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1984 ANNUAL REVIEW

Special Report — March 1985

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MARKET DEVELOPMENTS

NATURAL URANIUM PRICES

Overview

The nuclear fuel market has been weakened in recent years by slack demand, inventory liquidations, a continuing excess of production over consumption of U_3O_8, and the expectation that new, low-cost uranium sources will be available as needed. Those trends continued during 1984, and the five-year trend toward lower natural uranium prices culminated in December's ten-year low for the Nuexco Exchange Value, at $15.25 per pound U_3O_8. Several developments were particularly noteworthy in a year characterized by the persistence of a buyer's market.

1. The US Department of Energy (USDOE) introduced the Utility Services enrichment contract (USEC). With the industry's return to what is essentially a requirements basis for enrichment, millions of pounds of uranium demand that had been created artificially by government-imposed, fixed-commitment enrichment contracts were removed from the market. Concessions obtained by some utilities on a case-by-case basis during negotiations for conversion to the USEC also made it easier to use their existing inventories to fill current requirements. The cumulative market effects of the USEC and inventory sales of enriched UF_6, quantified in Report 193 of September 1984, amounted to 120,000,000 pounds equivalent U_3O_8, through 1991. Now that utility requirements have been pushed farther out in time, the significant unfilled utility demand estimated to begin in the mid-to-late 1980s is unlikely to become apparent before the end of this decade.

2. Cancellations of nuclear power plants aggravated the already severe inventory overhang by adding substantial quantities of material to that already awaiting liquidation. Moreover, several utilities having delayed or canceled plants liquidated their stocks.

3. The discovery and extension of large, very-high-grade Canadian deposits reinforced the already strong market perception that uranium supplies will be plentiful well beyond the end of this century.

4. Production exceeded consumption by more than 40 percent despite a fifth consecutive year of price weakness. A number of US producers shut down their production operations and prepared to withdraw from the uranium business altogether.

5. Canada established itself as the world leader in uranium production. By almost doubling the output of the USA and South Africa, each of which produced about 15 percent of the world's uranium, Canadian producers accounted for almost 30 percent of 1984 production.

Supply, Demand and Prices

The Nuexco Exchange Value continued its decline from the $22-$24 level in the fourth quarter of 1983 to a temporary low of $17.00 in March 1984, thereby returning to the lowest level reached in 1983. Thereafter and through the third quarter of 1984 it remained at that approximate level.

Transactions amounting to almost four million pounds U_3O_8 equivalent had been made during March, effectively clearing the market of bargain-priced material. That event, coupled with the preoccupation of DOE's utility customers with their negotiation of terms and conditions for conversion to the USEC, caused the mid-year lull in market activity that led to six months of stable prices.

The relative stability of the second and third quarters was followed by a sharp decline during the fourth quarter. That decline was brought about by oversupply, discretionary buying patterns and aggressive competition among sellers for each opportunity. The Exchange Value ended the year at $15.25, its lowest point in ten years. Table 1 lists the Exchange Value for each month of 1984. Although price cutting had been the norm during the rest of the year, several producers declined to compete, so their material remained on the market throughout the year.

Supply figures during the first half of 1984 show utilities and producers to be represented almost equally. Unlike 1983, utilities dominated the demand category during 1984; after January, producer demand never accounted for more than 25 percent of all active spot and near-term demand. Supply was fairly evenly divided between U_3O_8 and UF_6 throughout the year. Table 2 lists the spot and near-term supply and demand for natural uranium and the supply-demand ratio for each month of 1984.

Many users filled current needs from stocks on hand, so unfilled current requirements were small. Demand was largely discretionary, in that buyers had the flexibility to buy and hold for future use or wait for better prices if they chose to do so. Buyers were predominantly European and US utilities.

Toward the end of 1984, record-low offering prices were needed to elicit any buyer interest, as expectations that the weak market would continue became more prevalent. On the selling side, the downward forces were led by large inventory holders seeking liquidation and producers driven to sell by considerations such as cash flow or strategic decisions to withdraw from the business. Enrichment tails assay swaps also released additional material into the market through brokers and trading companies.

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Table 1

1984 EXCHANGE VALUES, CONVERSION VALUES AND LOAN USE CHARGE RATES

Determined as of the Last Day of the Month	Published in Report Number	Exchange Value[1] (per lb. U_3O_8)	Conversion Value[2] (per lb. U in UF_6)	Loan Use Charge Rate[3] (per annum)
January	186	$20.50	$0.60	6%
February	187	$17.50	$0.30	6%
March	188	$17.00	$0.80	6%
April	189	$17.75	$0.80	6%
May	190	$17.75	$0.80	6%
June	191	$17.50	$0.00	6%
July	192	$17.50	$0.00	6%
August	193	$17.50	$0.80	6%
September	194	$17.50	$1.00	6%
October	195	$16.00	$1.00	6%
November	196	$15.50	$0.80	6%
December	197	$15.25	$0.80	6%
Annual Average		$17.27	$0.64	6%

[1]The *Exchange Value* is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month indicated.

[2]The *Conversion Value* is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the last day of the month indicated.

[3]The *Loan Use Charge Rate* is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month indicated.

Table 2

1984 SPOT AND NEAR-TERM[1] SUPPLY AND DEMAND FOR NATURAL URANIUM
(Active inquiries as reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Uranium Supply[2] (Available for Sale)	Uranium Demand[2] (Inquiries to Purchase)	Spot and Near-Term Supply/Demand Ratio	Exchange Value (per lb. U_3O_8)
January	186	4.2	0.5	8.3	$20.50
February	187	5.9	1.3	4.5	$17.50
March	188	6.1	3.8	1.6	$17.00
April	189	7.4	3.4	2.2	$17.75
May	190	5.2	2.4	2.2	$17.75
June	191	4.3	1.9	2.2	$17.50
July	192	2.9	0.9	3.1	$17.50
August	193	5.1	1.1	4.6	$17.50
September	194	5.5	1.0	5.8	$17.50
October	195	5.5	1.3	4.3	$16.00
November	196	5.2	1.3	4.0	$15.50
December	197	3.6	1.3	2.9	$15.25
Annual Average		5.1	1.7	3.0	$17.27

[1]For delivery within one year.

[2]Millions of pounds U_3O_8 equivalent.

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Distress selling was an important factor in the weak market of 1984. Several utility sellers of large quantities of inventory entered the market during 1984 as a result of the continuation of general setbacks to nuclear power plant construction programs. Once an internal decision is made to cancel a nuclear plant or convert it to another fuel source, a utility will offer its material at whatever price is necessary to close a deal. Similarly, once a producer has decided to cease production or abandon the business altogether, its decisions to make or buy will be made strictly on the basis of economics.

Discretionary buyers moved in and out of the market sporadically during the year. Some utilities that had low carrying costs were especially active in this manner, buying to hold for future needs. Whenever firm utility demand emerged, it stimulated vigorous competition among sellers. In the absence of firm demand, distressed sellers reduced prices to stimulate buyers' interest. Those two sources of price cutting were the prominent selling themes of 1984. The outlook for 1985 is for more of the same.

While inventory sales by distressed sellers accounted for more than 10,000,000 pounds U_3O_8 equivalent during 1984, that is only a fraction of the material that remains available, as several utilities have a high probability of liquidating their inventories in 1985. Transactions during 1984 proved that even fabricated fuel, though not fungible, can be sold on the spot market.

Millions of pounds of excess uranium from producer stocks were on the market throughout 1984 at prices above then-current Exchange Values. Those producers, many having high production costs and a traditional view of the market, often were unwilling to reduce prices to make sales. However, enough material was offered by aggressive sellers to maintain the supply excess and weaken market prices. On the other hand, producers from western Canada competed actively and effectively in both the spot/near-term and longer-term markets.

The strengthening of the US dollar during the second half of the year improved the already solid competitive position of non-US sellers in general. That situation continued into 1985, as the dollar, which had been the world's weakest major currency only five years ago, in late February broke through two symbolic barriers: 10 French francs and 2,000 lire to the dollar; it almost reached parity with the pound sterling. As shown in Table 3, the dollar appreciated by 6 to 61 percent during 1984 against the currencies of selected producer and consumer nations. The combined effects of the Exchange Value's decline and the dollar's appreciation are shown in Table 4. The result was a general decline, except in the case of South Africa's 12-percent increase. In each case, the result depended on the combined effects of the answers to three questions.

1. Was that nation primarily a producer or a consumer of uranium?
2. How were its uranium activities divided between the spot/near-term market and the longer-term market?
3. How much of those activities were denominated in US dollars?

Two examples will illustrate the reasoning employed in the preceding paragraph. South Africa is almost exclusively a seller of uranium, rather than a buyer. Its contracts are almost all denominated in US dollars. Therefore, one could conclude that, all other factors being equal, South Africa's uranium revenues *in rand terms* increased by 12 percent in 1984. However, South Africa's uranium prices are based not on the Exchange Value (or other spot/near-term prices) but typically are negotiated annually. Those prices declined much less in dollar terms than did the Exchange Value, probably only 10 percent or less. Thus, the prices received for South Africa's uranium were affected much more by the dollar's 61-percent appreciation against the rand, so that their unit prices *in rand terms* were perhaps 50 percent higher in 1984 than in 1983.

On the other hand, US producers suffered substantially from both effects. The stronger dollar made US exports more costly, so that market segment was almost closed to US producers. A large fraction of US producers' 1984 deliveries was based on spot/near-term prices, so they were also affected severely by the 31-percent drop in Exchange Value during the year. Similar reasoning applied to each country's situation will give an understanding of the combined uranium price effects.

Conversion Value

Sellers of conversion in the secondary market found limited interest in their offers during most of 1984. The Conversion Value fluctuated throughout the year, reaching a peak of $1.00 during September and October. June and July produced the first zero value for conversion in the four years Nuexco has been reporting the Conversion Value. Holders of concentrates were able for a time to swap for natural UF_6 at no cost, so no value was placed on the conversion component of UF_6 in the market. In this very thin market, a clear willingness to buy or sell a significant quantity by only one market participant can have disproportionate effects on a given month's Conversion Value. Table 1 lists the Conversion Values for each month of 1984.

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Table 3

EXCHANGE RATES[1]
(Currency per US dollar)

Country (currency)	As of Dec. 30, 1983	As of Dec. 28, 1984	Percent Change
Australia (dollar)	1.11	1.20	+8
Belgium (comm. franc)	55.70	62.97	+13
Canada (dollar)	1.24	1.32	+6
Finland (markka)	5.83	6.52	+12
France (franc)	8.34	9.65	+16
FRG (mark)	2.73	3.15	+15
Italy (lira)	1661	1933	+16
Japan (yen)	232.05	250.10	+8
Netherlands (guilder)	3.07	3.55	+16
South Africa (rand)	1.22	1.97	+61
Spain (peseta)	157.55	172.95	+10
Sweden (krona)	8.01	8.96	+12
Switzerland (franc)	2.18	2.59	+19
UK (pound)	0.69	0.86	+25
US (dollar)	1.00	1.00	0

[1]Currency exchange rates from the *Wall Street Journal* of the date indicated.

Table 4

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES

Country (currency)	per lb. U_3O_8 in Concentrates		Percent Change
	Dec. 31, 1983	Dec. 31, 1984	
Australia (dollar)	24.50	18.37	-25
Belgium (comm. franc)	1,226	960.33	-22
Canada (dollar)	27.38	20.13	-26
Finland (markka)	128.21	99.48	-22
France (franc)	183.49	147.20	-20
FRG (mark)	59.96	47.99	-20
Italy (lira)	36,545	29,480	-19
Japan (yen)	5,106	3,814	-25
Netherlands (guilder)	67.46	54.08	-20
South Africa (rand)	26.80	29.99	+12
Spain (peseta)	3,466	2,638	-24
Sweden (krona)	176.14	136.53	-22
Switzerland (franc)	47.98	39.54	-18
UK (pound)	15.19	13.10	-14
US (dollar)	22.00	15.25	-31

[1]Currency exchange rates from the *Wall Street Journal* of the date indicated.

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Even the generally low secondary market prices for conversion failed to elicit much buyer interest. Active conversion demand was greater than zero in only four months during the year. Table 5 summarizes the secondary supply and demand for conversion services for each month of 1984.

Loan Use Charge Rate

The Loan Use Charge Rate did not change during 1984, staying at 6 percent per annum; Nuexco was aware of only a few prospective buyers during the entire year. A number of potential lenders continued to offer a relatively large and stable supply. Table 5 lists the supply and demand for natural uranium loans. Most potential lenders have been utilities holding large stockpiles of unneeded material, much of it natural UF_6. Potential borrowers seemed to lose interest completely in taking loans when the downturn in spot and near-term market prices commenced in the final quarter of 1983.

Analysis of Uranium Sales Transactions

Table 6 shows a breakdown of 1984 natural uranium sales transactions listed in the Nuexco Monthly Report, as indicated by the month in which they were reported. The total of 55 transactions involved a quantity of 36.1 million pounds U_3O_8 equivalent; forty-five transactions involving about 12.8 million pounds (35 percent by weight) called for spot or near-term delivery and were made up of 56 percent natural UF_6 (19 transactions) and 44 percent concentrates (26 transactions). Ten transactions accounted for the remaining 23.3 million pounds (65 percent), which were sold under longer-term contracts; six U_3O_8 transactions accounted for 35 percent and four UF_6 transactions, all by Canadian producers, accounted for the remaining 65 percent (15.2 million pounds U_3O_8 equivalent). The foregoing amounts incorporate some data refinements received since the transactions were first published.

The 1984 uranium market developed somewhat more conventionally than in 1983; utilities were the primary buyers, and producers the major sellers. Utility buyers increased their market share (as indicated by amount of material involved in transactions) to 94 percent in 1984 from 66 percent in 1983. Producer buyers accounted for much less of the market, falling to 2 percent in 1984 from 11 percent in 1983. Other buyers—government entities,

Table 5

ACTIVE SUPPLY AND DEMAND FOR SECONDARY MARKET CONVERSION[1] AND NATURAL URANIUM LOANS:[2] 1984
(Active inquiries as reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Conversion Supply (millions of pounds U as UF_6)	Conversion Demand	Loan Supply (millions of pounds U_3O_8 equivalent)	Loan Demand	Exchange Value (per lb. U_3O_8)
January	186	3.2	0.3	3.0	0.0	$20.50
February	187	3.1	0.2	3.0	0.0	$17.50
March	188	3.6	0.1	3.5	0.0	$17.00
April	189	2.9	0.0	5.5	0.3	$17.75
May	190	2.9	0.0	7.0	0.8	$17.75
June	191	2.8	0.0	7.1	0.5	$17.50
July	192	2.8	0.0	7.1	0.0	$17.50
August	193	2.8	0.8	0.0	0.0	$17.50
September	194	2.8	0.0	0.0	0.0	$17.50
October	195	1.2	0.0	0.0	0.0	$16.00
November	196	1.2	0.0	0.0	0.0	$15.50
December	197	1.0	0.0	0.0	0.0	$15.25

[1]For delivery within three years.
[2]Data refer to spot and near-term demand, i.e., material to be delivered to the *borrower* within one year.
[3]Involving competitive price, terms and other conditions.

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trading companies, etc.—accounted for only 10 percent of material in 1984 transactions, down from 23 percent in 1983.

On the sellers' side, uranium producers became the dominant suppliers with 73 percent of the transactions, up from 44 percent in 1983. However, inventory redistribution continued to the extent that sales by non-producers represent inventory sales. Utility sellers as a portion of the market increased from 6 percent in 1983 to 7 percent in 1984. The third category, other sellers, amounted to 20 percent in 1984, down from 50 percent in the previous year. In 1985, inventory redistribution, a process that is necessary before market stability can be reached, is expected to continue.

Table 6

TRANSACTIONS: NATURAL URANIUM SALES[1] REPORTED BY NUEXCO DURING 1984
(Millions of pounds U_3O_8 equivalent)

SELLERS		BUYERS		
		Utilities	Producers	Others
Utilities	Spot/Near-term	1.64	.04	.71
	Long-term	0	0	0
Producers	Spot/Near-term	5.18	.82	.58
	Long-term	19.70	0	0
Others	Spot/Near-term	3.75	.05	0
	Long-term	3.65	0	0

[1] Does not include transactions which fall into one or more of the following categories:

a. Transactions which took place in 1983 but were reported in 1984;
b. Transactions which involved enriched uranium or fabricated fuel;
c. Transactions that Nuexco did not know about;
d. Transactions that Nuexco was aware of but chose not to report, either to protect client confidentiality or because Nuexco was not satisfied with the reliability of our information; and/or
e. A negotiation which has not advanced to such a degree that Nuexco would judge it a completed transaction. Because of the subjective nature of Nuexco judgments, some pending negotiations may have been reported as transactions only to fall through later. In these cases, the transaction was omitted from this table.
f. Finally, a transaction is not a delivery of material, and options or new deliveries from old transactions are not regarded as transactions.

The reporting of nuclear fuel market transactions is subject to numerous limitations. Among them, the following probably are the most restrictive.

1. Transactions that Nuexco did not know about, or those in which insufficient information could be reliably ascertained, are not reported.

2. Nuexco chooses not to report certain transactions (or certain information about a published transaction) if the reporting of such information would jeopardize client confidentiality.

3. Nuexco does not define a transaction to mean a delivery of material, nor are options or new deliveries from old contracts regarded as transactions. Rather, a transaction is a new agreement to purchase, loan, etc.

4. Because of the subjective nature of Nuexco's judgments, some agreements may be reported as transactions only to fall through later. A negotiation may be judged a transaction as soon as the parties verbally agree, or as late as contract signing, or even later, depending on Nuexco's confidence in the completion of delivery and payment.

5. The above analysis of 1984 transactions also did not include those which took place in 1983 but were reported in 1984, as well as transactions involving enriched uranium or fabricated fuel.

Transaction Value

Transactions included in the Transaction Value calculation are, in general, a subset of those listed under the category "Uranium Sales" in the *Current Market Data* section of each Report. Historically the Transaction Value, which is a weighted average of prices paid for natural uranium in spot and near-term transactions of immediately preceding months, has trailed the Exchange Value. This was true in the first four months of 1984, as the Transaction Value calculation retained transactions from late 1983, exchanged at higher prices. The earlier transactions were required in order to meet the minimum two million pounds of U_3O_8 or equivalent UF_6 stipulated in the Transaction Value parameters. Large quantities exchanged in the middle months of 1984 (at low prices) pushed the old quantities out of the calculation, and the Transaction Value fell below the Exchange Value for a five-month period. The closing months of 1984 exhibited a steep decline in the Exchange Value, and the Transaction Value also fell, but at a slower rate more characteristic of the gap between the two values. Table 7 lists the Transaction Value and its associated parameters for each month of 1984.

Thirty-three 1984 transactions were used in the Transaction Value calculations and their total quantity was 8.4

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million pounds equivalent U_3O_8. The weighted average price in those transactions was $16.73.

Loans and Secondary Market Conversion Transactions

Table 8 lists the four 1984 secondary market conversion transactions Nuexco reported. No uranium loans were reported in 1984; the relative ease of obtaining material at low prices has dampened the loan market considerably. Three of the four conversion transactions took place at prices well below the current Nuexco Conversion Value, illustrating the discretionary aspect of 1984 conversion demand.

Table 7 .

1984 TRANSACTION VALUES[1]
(and associated parameters)

Determined as of the Last Day of the Month	Report Number	Transaction Value (per lb. U_3O_8)	Millions of Pounds	Number of Transactions	Number of Months
January	186	$23.05	2.9	17	7
February	187	$22.50	2.0	13	7
March	188	$19.25	3.2	12	5
April	189	$17.90	2.5	10	5
May	190	$17.00	3.8	17	3
June	191	$16.50	5.4	18	4
July	192	$16.60	3.9	10	4
August	193	$16.40	3.9	10	4
September	194	$16.55	4.3	12	5
October	195	$16.05	2.7	10	5
November	196	$15.90	3.5	11	6
December	197	$15.90	3.7	16	7

[1]The *Transaction Value* is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
b. At least ten transactions;
c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.
The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

Table 8

1984 SECONDARY MARKET CONVERSION TRANSACTIONS REPORTED BY NUEXCO

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U equivalent)	Approximate Price as Percent of Current C.V.	Seller	Buyer	Remarks
2686	1984	101-300	100	US Producer	US Utility	
2685	1984	50-100	38	European Entity	US Utility	
2672	1984-5	601-1,000	73	US Utility	European Utility	Deconversion and origin swap.
3245	1985	101-300	63	US Producer	US Utility	Not an arm's length transaction.

No Uranium Loans were reported by Nuexco in 1984.

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SECONDARY MARKET ENRICHMENT SERVICES

Introduction

The secondary market for enrichment services was dominated during 1984 by reactions to the USEC, first by buyers and sellers, and then by DOE's competitors. SWU prices remained relatively stable throughout the year, despite the widespread repercussions caused by the USEC; two were especially important.

1. Eurodif and Urenco responded to the USEC with new offers. One type was aimed at utilities that had signed the USEC, but still had unfilled requirements due to their having committed for less than 100 percent of requirements. The other type of long-term contract was aimed at those utilities that had not signed the USEC.

2. The USEC eliminated millions of pounds of artificial uranium demand, and three US producers countered with a lawsuit against DOE, charging it with failing to maintain the viability of the US uranium production industry, among other allegations, and seeking to have the USEC invalidated.

Pricing Trends

Table 9 shows the Nuexco SWU Values for each month of 1984. By March, the market for FY84 DOE SWU seemingly had come to a close. Prices dropped from $115 in January to approximately $110 in February as sellers cut prices to compete for the diminishing demand.

In Report 188 (April 1984), Nuexco began publishing a FY85 DOE SWU Value. Like the utilities active in the late FY84 market, most active FY85 buyers consisted of utilities who had committed to the USEC, or recognized early that they would convert, and moved to secure SWUs at the lower prices available at the time. As the middle of the year approached, prices fell to an annual low of $105 per SWU during June and July, largely because of two events.

1. One seller entered the market intent on liquidating a large quantity of excess inventory and pursued particularly aggressive pricing policies.

2. In addition, it became possible for DOE customers retaining their fixed-commitment contracts (AFCs) to assign excess commitments to others that had notified DOE of their intent to convert to the USEC, thereby avoiding purchases at the higher AFC price. Thus, at a fixed discount, the net price through assignment was lower than the net price through a sale, permitting lower SWU prices for a short period of time.

Prices recovered toward the end of the year as low-price sellers disappeared, and the market stagnated. Last-minute sellers then began to compete aggressively for the little

Table 9

1984 SWU VALUES

Determined as of the Last Day of the Month	Report Number	DOE Origin FY84 Delivery	DOE Origin FY85 Delivery	DOE Origin FY86 Delivery[1]	Non-DOE Origin delivery within 15 Months	Non-DOE Origin delivery in CY86
January	186	$105	—	—	$85	—
February	187	$100	—	—	$83	—
March	188	—	$100	—	$80	—
April	189	—	$105	—	$80	—
May	190	—	$105	—	$80	—
June	191	—	$ 95	—	$80	—
July	192	—	$ 95	—	$85	—
August	193	—	$100	—	$85	—
September	194	—	$115	$20	$90	$98
October	195	—	$115	$20	$90	$98
November	196	—	$115	$15	$85	$95
December	197	—	$112	$15	$80	$90

[1]Discount from USEC base price on delivery.

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remaining demand. A small market for FY86 DOE SWU also emerged, but remained quiet as discounts ranging from $15 to $20 per SWU developed. Most FY86 buyers and sellers appeared content to wait for DOE's FY86 price announcement, now expected in April of 1985.

Throughout most of 1984, Nuexco published its SWU Values on the basis of an 0.2 weight-percent (w/o) tails assay. During the year, however, the nature of the market changed due largely to the terms of the USEC contract. Few, if any, buyers opted to purchase SWU at tails assays different from 0.3 w/o. Thus, in Report 194 (October 1984), Nuexco changed the derivation of its SWU Values to include an 0.3 w/o tails assay. (For this review of SWU prices, all values are presented on the basis of an 0.3 w/o tails assay.)

In the past, values for non-DOE origin SWUs have been highly responsive to DOE SWU Values, mainly because DOE and non-DOE SWU sellers competed for the same market. In late March of 1984, DOE established a policy that removed this dependency and further separated the two markets. The certification policy, instituted to stop displacement-type transactions, redefined the market such that the Nuexco DOE-origin SWU Value became the value for DOE-origin, *certifiable* SWU, and the non-DOE origin SWU Value became the *Other* SWU Value, reflecting the price for DOE-origin, non-certifiable SWU as well as for non-DOE origin SWU. The Other SWU Value for delivery within fifteen months remained stable during the first 10 months of the year, fluctuating between $90 and $95 per SWU. It fell to $85 in November and $80 in December as sellers became particularly aggressive.

As the market for calendar year 1986 delivery of Other SWUs developed, Nuexco began publishing in Report 194 (October 1984) a corresponding SWU Value. That value ranged from $90 to $98 per SWU over the last few months of the year, and followed the same general trend as the nearer-term value. The difference between the two values reflected the carrying costs associated with purchasing in 1985 for use in 1986.

Issues Arising from the USEC

In the months following the issuance of the USEC, it became apparent that the contract was popular among the vast majority of DOE's customers. Contract negotiations took place throughout the summer, and by the time all of the contract conversions were completed, DOE had modified the conversion terms to provide concessions to each class of customer. As a result, the degree of contract conversion exceeded even DOE's expectations. The only area where a significant number of customers did not convert was in Europe. Those defections were not unexpected, however, since both Urenco and Eurodif are multinational organizations.

The secondary market adjusted quickly to the new contract. The major change in market dynamics stemmed from the requirement that SWU used to offset deliveries under the USEC must be certifiable as excess through FY86 by the buyer (who consequently must obtain a similar warranty from the seller). This requirement amounted to a natural evolution of a similar requirement under the Interim Sales Contracts. DOE used the certification policy to thwart displacement transactions, in which DOE SWU were sold and replaced by lower-priced SWU of non-DOE origin. The buyer also had to certify that the proposed transaction did not allow a related displacement transaction to occur. Thus, in a number of cases, DOE was able to halt secondary market transactions by ruling that the SWUs were not certifiable, regardless of whether the buyers or sellers were willing to make such certification. DOE appears to be continuing this tactic in early 1985.

The issues surrounding the USEC were much more predominant outside of DOE's customer bases. In December 1984, three US uranium producers (Western Nuclear, Energy Fuels and Uranium Resources) filed suit against DOE on five counts. These producers contended that the plight of the US uranium industry was due to DOE actions and inactions. One of the counts charged that DOE unlawfully issued the USEC by not complying with the notice-and-comment requirements specified under the Administrative Procedures Act. Another count charged that DOE was unwilling to take measures to ensure the viability of the US uranium production industry as specified in the Atomic Energy Act. The suit contends therefore that the USEC should be invalidated. These three producers do not stand alone in their opinion that DOE mishandled the new contract.

Also in December, the General Accounting Office (GAO) released the results of its investigation into DOE's actions surrounding the issuance of the USEC. Among the major points of the GAO study are:

1. The guaranteed ceiling price in the USEC either conflicts with or is not specifically authorized in the present enrichment criteria;

2. Certain aspects of the enrichment program do fall under the requirements of the Administrative Procedures Act, and thus there may be some basis for the contentions of the plaintiffs in the suit mentioned above;

3. While it is accepted practice to write down non-producing assets, the amount of write-off of the gaseous

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diffusion plants DOE used in calculating the $135 per SWU price may be unlawful and inappropriate. (It has been recognized for some time that DOE can manipulate its accounting practices to attain certain SWU pricing goals.)

Thus, while the legality of DOE's actions came under closer scrutiny in 1984, DOE is now pursuing yet another program that will reduce prices on certain SWU to $90.

DOE's actions also invited criticism in terms of business strategy. The USEC was introduced under the new "businesslike" philosophy that DOE heralded during 1984. DOE attempted to foster a business image rather than that of a government service organization. In August 1984, Nuexco's J. Robert Wolcott gave testimony before the Tri-committee Advisory Panel on Uranium Enrichment. Below are some of his reflections capturing the nature of the business vs. government service debate. A more detailed discussion of Mr. Wolcott's comments may be found in Report 196 (December 1984).

1. **Full Cost Recovery**—Using a ten-year rolling pricing campaign, DOE arrived at a price of $135 per SWU. If every SWU sold in that period were sold at $135, in constant dollars, DOE would break even. At the same time, DOE shows SWU prices constantly decreasing over the same period. The $135 price is only a *ceiling* in this case. Reconciling these two sets of data, it appears DOE would *lose* $3 billion over the period.

2. **Market Forecast**—Comparing DOE's sales forecast (used in their pricing campaign) with demand over the same period, DOE must supply 70 percent of the world enrichment market to attain its goal. DOE's international market share would have to *increase* during a period when it is actually *decreasing* due to the forces of nationalism. DOE's forecasts have historically been optimistic, but is a continuation of this practice prudent for a "business"?

3. **DOE's April 1984 Pricing Campaign**—Comparing annual projected costs with revenues, DOE shows six years of losses before the first annual gain is achieved. In fact, through FY90, a cumulative loss of $3.4 billion is realized. Only after costs approach the $100 per SWU level (in constant dollars) can DOE recoup these losses. Furthermore, it is difficult to imagine costs approaching that level in the wake of developing new technologies which optimistically would be deployed in the mid-1990s.

In summary, DOE's actions, coupled with industry and government responses, do not support the claim that the US enrichment enterprise is moving in a more businesslike direction.

[1] Eurodif announced in late 1984 that it will offer two new enrichment contracts. One, the Flexible Services Contract, is a requirements-type contract which can be exercised by utilities wishing to fill the remaining 30 percent of requirements allowed under the USEC. Urenco offers a similar contract. DOE's incentive pricing campaign initiated in early 1985 is aimed at the same market. Eurodif also introduced a new long-term contract which will succeed its current contracts.

1984 Secondary Market Enrichment Transactions

Table 10 lists data regarding secondary market SWU transactions reported by Nuexco in 1984. The analysis includes transactions of which Nuexco is aware and possesses sufficiently complete data, and may include transactions which have been subsequently updated based on new information. A total of approximately 6.7 million SWUs were sold in 56 transactions. Approximately 65 percent of all transactions involved DOE-origin SWU, while the other 35 percent involved SWUs of non-DOE origin. 36 percent (20) of the total number of transactions involved FY84 deliveries, but the quantity of SWUs involved in those transactions, 1.5 million, was only 22 percent of the total quantity. Similarly, while 36 percent of the transactions involved FY85 deliveries, the number of FY85 SWUs sold (1.6 million) accounted for 24 percent of the total. The greatest quantity of SWUs, 52 percent (3.5 million), were sold for delivery in FY86 and beyond, also accounting for 36 percent of the transactions. Most of these sales entailed multiple annual deliveries. Four of the transactions involved deliveries in more than one of the three delivery period categories.

Table 10

1984 SECONDARY MARKET SWU TRANSACTIONS[1]

Delivery Period	Number of Transactions	Millions of SWUs
FY84	20	1.5
FY85	20	1.6
FY86 and beyond	20	3.5
All[2]	56[3]	6.7

[1] Only includes transactions which occurred in 1984. Does not include transactions for which Nuexco has incomplete or unreliable data. Some transactions may have been updated after original publishing.
[2] Approximately 65 percent of all transactions involved DOE origin SWUs, while the other 35 percent involved SWUs of non-DOE origin.
[3] Note that four transactions involved deliveries in more than one of the three delivery period categories.

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WORLD URANIUM PRODUCTION

In 1984, world uranium production increased 5 percent over the 1983 figure to almost exactly 100 million pounds U_3O_8. Substantial production increases in Australia and Canada offset the large decline in US output. France and Africa also produced slightly less in 1984. A comparison of Nuexco production estimates for 1983 and 1984 is presented in Table 11.

Table 11

1984 WORLD URANIUM PRODUCTION[1]
(Millions of pounds U_3O_8)

Country	1983	1984	Percent Change
Australia	8.4	10.3	+23
Canada	18.6	29.1	+56
France	8.5	8.2	- 4
South Africa[2]	15.8	15.0	- 5
Other Africa	21.2	20.4	- 4
Other	1.7	1.7	0
Subtotal	74.2	84.7	+14
United States	21.2	15.6	-26
TOTAL	95.4	100.3	+ 5

[1]Nuexco estimates.
[2]Includes estimate for Palabora Mining Company.

Australia's 1984 production increase came from greater output at Energy Resources of Australia's (ERA) Ranger mine. A higher rate of production compensated for a lower than normal output in 1983 that had been caused by several months unexpected shutdown. While Ranger is now producing at normal levels, the completion of Queensland Mines, Ltd. production at Nabarlek means that Australian production cannot be expected to equal its 1982 peak of 11,600,000 pounds U_3O_8 without new capacity.

Canadian production increased as Key Lake Mining Corp. reached its monthly capacity of 1 million pounds, finishing the year with 10.4 million pounds total output. Canada produced more uranium than any other country in the world and will continue to do so for the foreseeable future.

The decline in US production continued the trend that began in 1981. With the closure of Kerr McGee's Quivira Mining Company mine and mill at Grants, New Mexico, announced in January 1985, that downward trend is certain to continue through 1985. Not all US producers are reducing production; phosphate producers are in some cases increasing uranium output due to the strength of the fertilizer industry. However, the conventional operations have been hit the hardest. Of the ten conventional mills operating in 1985, about half will continue producing through 1986.

As indicated in Table 12, Nuexco projects world uranium production in 1985 will decline to approximately 94,000,000 pounds. Australian production will be almost unchanged from 1984; South African output will drop slightly as two announced mine closures take effect, and the USA will continue its downward slide. As expected, Canada will represent the only encouraging sign. Canadian production will increase slightly, with the Key Lake project operating at full capacity for an entire year.

It is worth noting that while estimates made at the end of each year are reasonably accurate for their intended purpose, they are far from perfect. Thus, Nuexco updates its estimates of historical production from time to time. Nuexco's latest estimates of historical uranium production for 1980 to 1984 (and forecast for 1985) are presented in Table 13. We welcome any additional refinements to our data.

Table 12

1985 WORLD PRODUCTION FORECAST
(Millions of pounds U_3O_8)

Country	1984[1]	1985	Percent Change
Australia	10.3	9.8	- 5
Canada	29.1	29.9	+ 3
France	8.2	8.0	- 2
South Africa[2]	15.0	13.7	- 9
Other Africa	20.4	19.5	- 4
Other	1.7	2.4	+41
Subtotal	84.7	83.3	- 2
United States	15.6	10.5	-33
TOTAL	100.3	93.8	- 6

[1]Nuexco estimates.
[2]Includes estimate for Palabora Mining Company.

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Table 13

WORLD[1] URANIUM PRODUCTION 1980-1985[2]
(Millions of pounds equivalent U_3O_8)

Country	1980	1981	1982	1983	1984	1985
Australia	4.1	8.1	11.6	8.4	10.3	9.8
Canada	18.6	20.1	21.0	18.6	29.1	29.9
France	6.8	6.6	7.8	8.5	8.2	8.0
South Africa	16.0	15.9	15.1	15.8	15.0	13.7
Other Africa	23.9	24.3	23.4	21.2	20.4	19.5
Other Nations	1.8	1.1	1.9	1.7	1.7	2.4
USA	43.7	38.7	26.8	21.2	15.6	10.5
Total	114.9	114.8	107.7	95.3	100.3	93.8
(rounded)	115	115	108	95	100	94

[1]Outside Soviet bloc areas.
[2]1980-1984 data are Nuexco's best estimates. 1985 data are Nuexco forecasts.

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AUSTRALIA

Political Developments

Governmental policy decisions once again played the dominant role in Australia's uranium production industry in 1984. The ruling Australian Labor Party (ALP) continued to administer policies consistent with the party's platform, which at one time called for the cessation of uranium mining. The government moderated its stance somewhat by allowing production at the Nabarlek and Ranger mines to continue; it also recognized the economic importance of the copper/uranium deposit at Olympic Dam (Roxby Downs) by allowing its development to proceed. However, in July 1984 the ALP essentially reaffirmed the uranium policy that it had tentatively established in November 1983. Although the policy allowed the continuation of production at Ranger (Nabarlek has ceased operations), it included the following restrictions:

1. It prohibits the mining of any undeveloped uranium properties other than Olympic Dam;
2. It forbids the export of Australian uranium to France as long as the French military performs nuclear weapons testing in the Pacific;
3. Finally, it prohibits the construction of nuclear power plants or fuel cycle facilities in Australia.

The ALP's action at the July party convention came as somewhat of a disappointment, especially insofar as it ran counter to several strong recommendations to relax somewhat its stringent policy. The Australian Science and Technology Council (ASTEC), in a May 1984 report, strongly advocated a more active role for Australia in the international nuclear fuel cycle. The report followed an inquiry, entitled "Examination of the Issues Related to Australia's Role in the Nuclear Fuel Cycle," commissioned by the government to assess Australia's safeguards arrangements and other sensitive fuel cycle issues. The report argued that greater involvement will place Australia in a better position to influence the non-proliferation of nuclear weapons, as well as the safe use of nuclear power. It also suggested that Australia consider developing domestic programs for uranium enrichment and spent fuel reprocessing in addition to expanding research on radioactive waste management.

In addition to the ASTEC report, several key government ministers argued that the ALP policy lessens Australia's ability to influence international nuclear issues, and harms relations with important European trading partners. Nevertheless, the ALP firmly reiterated its earlier prohibition of mining of undeveloped uranium properties (except Roxby Downs), uranium exports to France, and development of nuclear power plants or fuel cycle facilities.

The government dealt another setback to Australia's already reeling uranium industry in September, when the previously declared ban on uranium exports to France made its first commercial impact. Although the ban technically had been in effect since early 1983, it had been moot until Queensland Mines, Ltd. (QML) was due to make new shipments under a contract with Electricite de France (EDF). The contract, negotiated in 1981, called for the delivery of 6.8 million pounds U_3O_8 between 1982 and 1988. Without EDF's consent to void the contract, QML would have had to declare force majeure or become liable for breach of contract. Shortly thereafter the Australian government intervened, announcing that it had agreed to purchase 1.6 million pounds U_3O_8 over the next two years. It agreed to purchase each of the next eight shipments at the original delivery price. Based on an Australian floor price of approximately US $31, the compensation would approach US $50 million over the next two years. The purchase relieved the ALP of pressure from the uranium producers for the time being, until Australia's uranium export policies can be modified or circumvented.

Olympic Dam Project

Despite these uncertainties, the joint venture partners developing the Olympic Dam (Roxby Downs) project are optimistic. The partners, Western Mining Co. (WMC) and BP Australia, launched a full-scale feasibility study (A$150 million) in late 1984. The Chairman of WMC announced that full production would be achieved in stages because of limited uranium marketing opportunities before 1990. The study, scheduled for completion in early 1985, also indicated initial production of the Roxby Downs ore body would concentrate on high-grade gold areas. The first stage would be designed to treat ore averaging three percent copper, 3.3 pounds U_3O_8 and 0.4 grams of gold per ton of ore. Annual yield would include 2,000 metric tons U_3O_8.

The impact of the feasibility study and subsequent pilot plant operation may have been underestimated by observers, because the plant would constitute almost a complete first stage. The significance of the deposit lies not only in its immensity, estimated at 2,800 million pounds U_3O_8 (at an average grade of 0.06 percent) in addition to vast copper reserves, but also in its diversity. With the emphasis on co-product production, the partners hope to begin production in the late 1980s.

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AUSTRALIA

Production Results

Overall Australian production increased 23 percent over 1983 production to 10.3 million pounds, second only to Canada in percentage increase. The 1.9-million-pound U_3O_8 increase can be attributed to greater output at ERA's (Energy Resources of Australia) Ranger mine, which reported production of 7.6 million pounds U_3O_8. A higher rate of production compensated for the 1983 output, which was lower than normal. Nuexco does not expect Ranger to meet this level of production in 1985. Queensland Mines Ltd., operator of the Nabarlek mine, continued production at its 1983 level, reporting production of 2.8 million pounds U_3O_8. The government purchase of the EDF material allowed production to continue at normal rates.

ERA recently expanded its market share by signing long-term supply contracts with two US utilities. American Electric Power Co., in a renegotiation of a previous contract, and Pennsylvania Power and Light Co. signed contracts reportedly totalling 6.5 million pounds U_3O_8. Deliveries are scheduled to begin late in the decade, although Nuexco's information indicates that the contracts are organized in such a way to allow considerable delivery flexibility. It is unlikely that US utilities would agree to terms that would require them to buy large amounts of material at prices substantially higher than spot market prices. Therefore, the agreements probably are structured as call options, which would allow the utilities to call on ERA for delivery at discounts from market price if and when the Australian floor price falls below market price. Accordingly, the contracts probably do not require the utilities to take and pay for any meaningful quantities while the market price is below the Australian floor.

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CANADA

Uranium Production

Canada led the world in uranium output in 1984 as production totaled 29.1 million pounds U_3O_8, compared to 18.6 million pounds in 1983. The 56-percent increase came about as a result of a full year's production from the Key Lake project in northern Saskatchewan, which began milling ore in October 1983, and the higher production achieved at the Stanleigh Mine at Elliot Lake, Ontario, which had been restarted in late 1983. The Key Lake Mining Company, owned by SMDC (50 percent), Uranerz Exploration and Mining (33.3 percent) and Eldor Resources Ltd. (16.7 percent), produced 10.4 million pounds U_3O_8 in 1984, up from 1.6 million pounds in 1983. Stanleigh, operated by Rio Algom Ltd., produced approximately one million pounds U_3O_8, double its 1983 output.

The Key Lake project became the world's largest uranium production center in 1984 (as measured by output, rather than ore milling capacity). If 1985 production levels (currently one million pounds per month) are maintained, the plant's design annual capacity of 12 million pounds U_3O_8 will be achieved as scheduled. Production can be sustained at that level for the next 12 to 15 years.

Almost continuous exploratory drilling at the Cigar Lake deposit in 1984 more than doubled preliminary estimates of reserves. The deposit is divided into two principal areas of mineralization. The main ore deposit contains reserves of 285 million pounds U_3O_8 at an average grade of 14 percent U_3O_8 (12 percent elemental uranium). A narrowing extension of ore to the west, referred to as the tail, contains an estimated 100 to 150 million pounds at an average grade of 4.7 percent U_3O_8.

Cogema Canada Ltd., the operator of the project, will continue evaluation through 1985 and beyond. Exploration drilling currently is in progress along zones thought to have high potential for ore extensions. However, the primary drilling effort is concentrated within the main ore deposit in order to better establish reserve estimates and to develop a feasibility plan for ore recovery.

Ownership of the Cigar Lake development is divided between Cogema Canada (32.625 percent), Saskatchewan Mining Development Corporation (50.75 percent), Idemitsu Uranium Exploration Canada Ltd. (12.875 percent) and Corona Grande, a wholly-owned subsidiary of Cogema Canada (3.75 percent).

Nuclear Power Developments

There are currently fourteen Candu (pressurized heavy-water moderated and cooled) reactors in commercial operation in Canada, and nine reactors under construction or planned (Table 14). Two Ontario Hydro units entered commercial operation in 1984, and the utility shut down its Douglas Point reactor after 16 years of commercial operation. Ontario Hydro's Pickering Unit 6, a 515-MWe Candu, entered commercial operation in February 1984, and Bruce Unit 6, a 750-MWe Candu, entered commercial operation in September 1984. (In addition, the 515-MWe Pickering Unit 7 began commercial operation in January 1985.) The addition of the two units increased Canada's installed capacity from 7.0 gigawatts (GWe) in 1983 to 8.1 GWe in 1984. Ontario Hydro expects two more units to enter commercial operation in 1985, Bruce Unit 5 and Pickering Unit 8. These units, combined with the Pickering Unit 6 already in operation, will contribute to a 21-percent installed capacity increase in 1985. All reactors scheduled for commercial operation by 1992 are now under construction, with the exception of Point Lepreau Unit 2. Maritime Nuclear, an independent company created to establish the Point Lepreau Unit 2 project, invited contractor proposals in February 1984. A final decision is pending. The plant would be North America's first nuclear power plant on order since 1978. Maritime Nuclear is a government-owned company jointly formed by Atomic Energy of Canada and New Brunswick Electric Power Company.

Ontario Hydro's four Bruce units had an aggregate gross capacity factor of 94 percent in 1984. Bruce Unit 6, in commercial operation since September, had a 99-percent gross capacity factor for the fourth quarter. Bruce Unit 5, scheduled for commercial operation in April 1985, reached full power in January 1985, and may go into service ahead of the scheduled date. Ontario Hydro announced that the present workforce at Bruce Nuclear Power Development will be reduced by 40 percent over the next three years. The last two of the eight Bruce reactors will be completed by 1987, necessitating a layoff of nearly all of the 2,400 construction workers. By the time Units 7 and 8 are complete, the construction costs will have totaled C$10.5 billion for the eight plants.

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CANADA

Table 14

NUCLEAR POWER PLANTS IN CANADA

Unit	Utility	MWe (net)	Percent Complete	Commercial Operation Date
Commercial Operation				
Pickering 1	Ontario Hydro	515	100	Jul 1971
Pickering 2	Ontario Hydro	515	100	Dec 1971
Pickering 3	Ontario Hydro	515	100	Jun 1972
Pickering 4	Ontario Hydro	515	100	Jun 1973
Bruce 1	Ontario Hydro	740	100	Sep 1977
Bruce 2	Ontario Hydro	740	100	Sep 1977
Bruce 3	Ontario Hydro	740	100	Feb 1978
Bruce 4	Ontario Hydro	740	100	Jan 1979
Point Lepreau 1	New Brunswick EPC[1]	630	100	Jan 1983
Pickering 5	Ontario Hydro	515	100	May 1983
Gentilly 2	Hydro Quebec	640	100	Sep 1983
Pickering 6	Ontario Hydro	515	100	Feb 1984
Bruce 6	Ontario Hydro	750	100	Sep 1984
Pickering 7	Ontario Hydro	515	100	Jan 1985
Total		8,585		
Under Construction or Planned				
Bruce 5	Ontario Hydro	750	100	Apr 1985
Pickering 8	Ontario Hydro	515	95	Jul 1985
Bruce 7	Ontario Hydro	750	75	Apr 1986
Bruce 8	Ontario Hydro	750	60	Jan 1987
Darlington 2	Ontario Hydro	880	48	May 1988
Darlington 1	Ontario Hydro	880	23	Feb 1989
Darlington 3	Ontario Hydro	880	3	Nov 1991
Darlington 4	Ontario Hydro	880	1	Aug 1992
Point Lepreau 2	New Brunswick EPC	630	0	indefinite
Total		6,915		
Shut Down				
Douglas Point	Ontario Hydro	206	100	Sep 1968

[1]EPC = Electric Power Company.

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CENTRAL AFRICA

Niger

Output from Niger's uranium operations in 1984 was more than four percent less than the 1983 level. The two operating projects, Akouta and Arlit, produced 8.5 million pounds U_3O_8. Niger owns shares in all uranium projects through the state company Onarem (Office National des Ressources Minieres).

The underground mine at Akouta began production in mid-1978. The project currently produces slightly more than half of Niger's uranium. Cogema, which owns a 34-percent share and also operates the project, purchases approximately half the output. The mine also produces molybdenum as a by-product. The Arlit project, also operated by Cogema, involves open-pit mining of three related sedimentary deposits, with ore processed in two operating mill facilities. Shareholders include Onarem (33 percent), Cogema (27 percent) and Mokta (19.4 percent). The mine is located in the Agadez Basin, seven miles northeast of Akouta.

Both the Akouta and Arlit operations considered production cutbacks of up to 40 percent in 1984 due to reduced demand, but those cutbacks never took place, possibly because Niger delivers most of its material under long-term contracts and also because the country is heavily dependent on foreign trade. Uranium accounts for approximately 70 percent of Niger's export earnings. Although uranium accounted for 45 percent of the state budget in 1979, that figure has been declining and is expected to fall below 15 percent in 1985. Currently Onarem is waiving its option to purchase U_3O_8 from the two operations because of a lack of sufficient demand in the world market.

Gabon

Uranium production in Gabon declined ten percent in 1984, as total output fell to 2.3 million pounds U_3O_8. The Mounana mill, with a 440,000 metric ton annual capacity, processes all of the ore extracted from the nearby Oklo and Boyindzi deposits, containing average grades of 0.3 to 0.4 percent U_3O_8.

The owner of the project is Comuf (Compagnie des Mines d'Uranium de Franceville), a company organized under Gabonese laws for the purpose of mining the Franceville Basin uranium deposits. It leases a 1,150 square kilometer concession area originally granted by the government of Gabon to the French CEA (Commissariat a l'Energie Atomique). The Comuf ownership structure is comprised of several interests, including Compagnie Francaise Mokta (39 percent), which operates the project, the Gabonese state (24.8 percent), Cogema (18.8 percent), Pechiney (13 percent) and the Gabonese public (4.4 percent). Most Mounana production goes to Cogema, while other European and Japanese buyers receive shipments under short and medium-term contracts. Comuf, Cogema and Kepco (Korea Electric Power Company) are involved in exploration programs in and around the existing concession area.

Uranium accounts for approximately seven percent of Gabon's export earnings. The Transgabonais railway, currently under construction, will link the interior of the country to the coast, facilitating the transport of uranium, among other things.

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EUROPE

EUROPE

Introduction

The European Economic Community (EEC), in a recent forecast of energy growth, reported a provisional four-percent rise in member countries'[1] energy consumption in 1984. Nuclear power demonstrated the strongest growth compared to coal, hydro, and other sources, supplying about 26 percent of EEC electricity in 1984. The forecast indicates that nuclear power will provide 30 percent of member states' electricity needs in 1985. EEC figures predict member countries' nuclear capacity will reach 68 gigawatts (GWe) by the end of 1985, almost 50 percent higher than in 1983. Nuexco figures project approximately 64 GWe by the end of 1985.

These expectations are bolstered by the overall progress of nuclear power programs in Europe in 1984. For example, in France and Belgium, over half of the electricity was generated by nuclear power. Other countries, such as Sweden, the Federal Republic of Germany and the UK, continued to expand well-established programs. Switzerland and Italy further developed projects which were initiated in recent years. Despite the reemergence of the political debate over nuclear power, in which various public groups, political parties and governmental mandates attempted to limit its development or use, European nations in general advanced toward greater energy dependence on domestic nuclear sources.

AUSTRIA

The fate of the 720-MWe Zwentendorf BWR remained in doubt at the end of 1984. The finished plant has been idle since 1979, when the Austrian Parliament passed a law banning the use of nuclear power. The law was motivated by a popular vote against nuclear power some months before. Fierce opposition to the plant's operation still exists, and a two-thirds majority vote by members of Parliament is required to overturn the law. Even if the law were repealed, it would be politically necessary to hold a referendum on the plant's future.

The $700-million reactor now requires a staff of 40 to maintain it, at a cost of approximately $3 million per year. GKT (Gemeinschaftskernkraftwerk Tullnerfeld), the plant's utility, in 1984 began exploring ways to dispose of the Kraftwerk Union–built reactor. GKT has considered tearing down the unit and selling the spare parts, as well as transferring the entire plant to another country. Conversion of the plant to another fuel source has been deemed uneconomic by a study conducted for the trade ministry. Nevertheless, it is apparent that the electricity is needed, because Austrian dependence on electricity imports increased by 40 percent in 1983 and Austrian electricity imports surpassed exports for the first time.

The ruling Socialist-Liberal coalition will continue to debate the project. The Socialists have supported the project and in late 1984 announced they will make one last attempt to put the plant back into operation. The Liberals, under pressure from vocal environmental groups, said they would not accept any favorable mention of Zwentendorf in a national energy policy. Some resolution of the impasse is expected by the middle of 1985.

In related developments, GKT studied the possibilities of an arrangement whereby China would take spent fuel from the Zwentendorf reactor, seemingly solving the waste disposal issue which is a major obstacle to the unit's operation. Other nations had been approached with the idea of accepting Austria's spent fuel, but the process had met without success.

BELGIUM

Electricity consumption increased five percent in 1984, and nuclear power was responsible for 51 percent of Belgium's electricity. Coal, natural gas and nuclear power together generate almost 90 percent of the country's electricity. Five PWRs, with a capacity of 3,450 MWe, are in commercial operation, and two more are 95-percent completed. The units are divided between two plants: Tihange, near Liege, site of Tihange Units 1, 2 and 3, and Doel, near Antwerp, site of Doel Units 1, 2, 3 and 4. Tihange Unit 3 and Doel Unit 4 are 1,000-MWe PWRs scheduled for commercial operation in June 1985. Intercom, Belgium's largest utility, expects the government to decide soon regarding construction of an eighth unit. The Doel site has been considered as a possible location. Intercom hopes the French state utility Electricite de France (EDF) will also participate in the project, which probably will be a 1,300-MW reactor.

Following more than two years of negotiations, Belgium and France have agreed to cooperate on the construction of two 1,300-MWe nuclear reactors at Chooz, just across the French border. Under the agreement, Bel-

[1]The ten EEC member nations are Belgium, Denmark, France, FRG, Greece, Ireland, Italy, Luxembourg, Netherlands, and the UK.

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gian utilities will assume a 25-percent share in the two Chooz units, and 22.5 percent of the construction orders will go to Belgian industry. In return, French industry will receive 45 percent of the orders for the planned Belgian plant, and EDF will have the option of buying 50 percent of the plant's output. Under the accord, Belgian utilities have agreed to place construction orders for the new plant by March 1987. If electricity demand continues to grow, it is likely a decision to build an eighth unit will be forthcoming.

Synatom, the company which provides fuel cycle services to Belgian utilities, has sufficient enrichment coverage for all of Belgium's plants. A 50-percent partner (with the Belgian government) in Soben, which owns 11.1 percent of Eurodif, Synatom takes 100 percent of its enrichment needs from Eurodif. The two units nearing commercial operation also are covered by Eurodif enrichment.

FINLAND

This country has, in keeping with its relatively small population, a small nuclear power program. Two 445-MWe PWRs supplied by the USSR and two 660-MWe BWRs supplied by Sweden's Asea-Atom consistently have achieved capacity factors in the 80 to 90-percent range, and nuclear electricity generation per capita is the highest in the world. The plants supplied 41.1 percent of Finland's electricity in 1984.

Two utilities operate the four units. IVO (Imatran Voima Oy), a state-owned utility, operates the USSR-built units at Loviisa on the southeastern Baltic coast. TVO (Teollisuuden Voima Oy) operates the Asea-Atom BWRs at Olkiluoto on the southwestern coast. IVO orders its fuel each year from the USSR under a contract that stipulates the return of all spent fuel, relieving the utility of the responsibility for long-term waste storage. TVO purchases from the commercial uranium market. The USSR supplies both utilities with all of their enrichment requirements.

Electricity demand in Finland is forecast to grow approximately three percent per year until 1995. The current installed electrical capacity is expected to be sufficient until the early 1990s. Discussions regarding the possibility of a fifth nuclear unit in Finland took place throughout 1984, but a serious commitment was not announced. If it materializes, the project may involve a joint effort between the two utilities. Possible choices for the fifth reactor include a Soviet 1,000-MWe unit (VVER-1000), a Framatome 900-MWe PWR supplied by France, or another Swedish BWR. Site selection is likely to depend on the reactor origin; a Soviet unit probably would be built at the Loviisa site, while a French or Swedish unit would be built at Olkiluoto. However, in 1984 Finland initiated a reform of its nuclear legislation under which the national Parliament will have to approve construction of future nuclear plants. The legislative process could extend through 1985, so at present its effect on future units is unknown.

FRANCE

Nuclear Power

With the addition to the grid of seven new PWRs during 1984, Electricite de France (EDF) now produces approximately 65 percent of its total generation from nuclear power stations. The French state utility is currently operating 41 units at 12 stations, including two 1,300-MWe PWRs at the Paluel site in Normandy (Figure 1). Twenty additional units are currently under construction. By the end of 1990, EDF is scheduled to operate approximately 65 units at 21 stations in France, for a total net generating capacity of 61,403 MWe (Table 15). In addition, France concluded an agreement with Belgium in May to cooperate on the joint construction of the two-unit Chooz plant near the Belgian border. EDF issued plans in April for the decommissioning of three plants by 1986. One reactor, Marcoule Unit G3, was decommissioned in July 1984 after 25 years of service.

EDF and the US Electric Power Research Institute (EPRI) published late in 1984 the results of a joint study of plant construction programs in France and the USA which confirms EDF's successes.[1] Four principal conclusions of the study were:

1. The total capital costs for a French PWR average approximately 60 to 70 percent of the costs of a similarly sized unit in the USA.

2. Total craft labor requirements for a French unit may be as little as half those for a similar US plant. Requirements for non-craft labor are also much lower in France. (In the USA, non-craft labor costs are the fastest-rising component of base plant costs.)

3. While safety standards governing French plants are similar to those governing US plants, the regulatory structure is far more stable in France than in the USA.

[1] "A Comparative Review of US and French Power Plant Construction Projects," presented at the ANS/ENS International Conference in Washington, DC (November 1984).

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Figure 1

NUCLEAR PLANT SITES AND URANIUM PRODUCTION CENTERS IN FRANCE

[1]Chooz Unit A is a 300-MWe PWR. The Chooz plant is operated by SENA (Societe Nucleaire Franco-Belge des Ardennes).

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Table 15

NUCLEAR POWER STATIONS IN FRANCE

Unit	Net MWe	Type	COD	Percent Complete
Belleville 1*	1275	PWR	1988	50
Belleville 2*	1275	PWR	1988	40
Blayais 1	910	PWR	1981	100
Blayais 2	910	PWR	1983	100
Blayais 3	910	PWR	1983	100
Blayais 4	910	PWR	1983	100
Bugey 1	540	GCR	1972	100
Bugey 2	920	PWR	1979	100
Bugey 3	920	PWR	1979	100
Bugey 4	900	PWR	1979	100
Bugey 5	900	PWR	1980	100
Cattenom 1*	1265	PWR	1986	70
Cattenom 2*	1265	PWR	1987	55
Cattenom 3*	1265	PWR	1989	20
Cattenom 4*	1265	PWR	1990	5
Chinon A2	210	GCR	1965	100
Chinon A3	400	GCR	1967	100
Chinon B1	870	PWR	1984	100
Chinon B2	870	PWR	1984	100
Chinon B3*	870	PWR	1987	55
Chinon B4*	870	PWR	1988	40
Chooz A	310	PWR	1967	100
Chooz B1**	1400	PWR	1991	0
Chooz B2**	1400	PWR	1992	0
Creys-Malville*	1200	LMFBR	1985	95
Cruas 1	880	PWR	1983	100
Cruas 2	880	PWR	1984	100
Cruas 3	880	PWR	1984	100
Cruas 4	880	PWR	1984	100
Dampierre 1	890	PWR	1980	100
Dampierre 2	890	PWR	1981	100
Dampierre 3	890	PWR	1981	100
Dampierre 4	890	PWR	1981	100
Fessenheim 1	880	PWR	1977	100
Fessenheim 2	880	PWR	1978	100
Flamanville 1*	1290	PWR	1985	85
Flamanville 2*	1290	PWR	1987	65

See footnotes next page.

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Table 15

NUCLEAR POWER STATIONS IN FRANCE *(continued)*

Unit	Net MWe	Type	COD	Percent Complete
Golfech 1*	1275	PWR	1990	5
Golfech 2**	1275	PWR	1991	0
Gravelines B1	910	PWR	1980	100
Gravelines B2	910	PWR	1980	100
Gravelines B3	910	PWR	1981	100
Gravelines B4	910	PWR	1981	100
Gravelines C5	910	PWR	1984	100
Gravelines C6*	910	PWR	1985	85
Marcoule G2	40	GCR	1959	100
Marcoule G3[1]		GCR	1960	100
Phenix	233	LMFBR	1973	100
Monts d'Arce	70	GCHWR	1967	100
Nogent sur Seine 1*	1275	PWR	1988	40
Nogent sur Seine 2*	1275	PWR	1989	35
Paluel 1	1290	PWR	1984	100
Paluel 2	1290	PWR	1985	100
Paluel 3*	1290	PWR	1985	90
Paluel 4*	1290	PWR	1986	75
Penly 1*	1290	PWR	1990	5
Penly 2**	1290	PWR	1991	0
St. Alban 1*	1300	PWR	1985	90
St. Alban 2*	1300	PWR	1986	75
St. Laurent A1	460	GCR	1969	100
St. Laurent A2	515	GCR	1971	100
St. Laurent B1	880	PWR	1983	100
St. Laurent B2	880	PWR	1983	100
Tricastin 1	915	PWR	1980	100
Tricastin 2	915	PWR	1980	100
Tricastin 3	915	PWR	1981	100
Tricastin 4	915	PWR	1981	100
Total MWe	61,613			

* Unit under construction.
** Unit on order or planned.
[1] Marcoule Unit G3 was decommissioned in 1984. Chinon Unit A2 will be decommissioned in 1985.
[2] Chooz Unit A is owned and operated by SENA (Societe Nucleaire Franco-Belge des Ardennes).
[3] The Super-Phenix fast breeder reactor is being built by NERSA, a European consortium of which the principal shareholders are EDF (51 percent), ENEL (33 percent), and SBK (16 percent).

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4. Plant costs are reduced greatly when the utility employs standardized plant designs and units are replicated on site. EDF's successful record can be attributed in large measure to the use of one highly experienced vendor, Framatome, and to the practice of multiple-unit siting.

During 1984 EDF continued to export electricity to the Netherlands, Belgium, the FRG, Switzerland, Italy and Spain. Utilities in some of these countries have invested directly in French nuclear plants. Spain and Italy imported electricity from EDF in 1984 under agreements reached with Eurodif, in which both countries are shareholders. Eurodif is EDF's largest industrial customer; the four-unit Tricastin plant, located at the Eurodif site, supplies electricity to both Eurodif and Comurhex.

In another electricity-export project, the first phase of a grid link between France and the United Kingdom was completed during 1984 and is scheduled to begin transporting power this year. The joint venture between EDF and the Central Electricity Generating Board (CEGB) will eventually trade power between the countries. The 2,000-MW sealink connection under the English Channel is designed to take advantage of the difference in peak hours between France and the UK.

Fuel Supply

EDF receives most of its annual fuel requirements (over 15 million pounds U_3O_8 equivalent in 1984) from the state fuel cycle company Cogema or from EDF's own stockpile. The utility has also taken deliveries from non-French suppliers, including the Australian producer Queensland Mines Ltd. (QML). The Australian government decided in 1984 to prohibit QML from exporting concentrates to EDF in 1985, as a protest against the testing of nuclear weapons by the French military in the South Pacific. The action has had little effect on EDF's supply position.

Uranium Production

Cogema is an operator or leading shareholder of uranium mining operations in France, Central Africa, Western Canada and the USA (Figure 2). Those operations account for approximately 20 percent of the world's commercial uranium production. Many of the projects exploit relatively high-grade deposits as compared to most of the non-Canadian mines currently in operation in the world. Concentrates delivered from those operations during 1984 were sold under long-term marketing arrangements. Cogema delivers uranium to a number of Japanese and European utilities in addition to EDF. As the operator and a 36.4-percent shareholder in the Waterbury Lake joint venture in the Canadian province of Saskatchewan, Cogema continued during 1984 to explore the richest and most important uranium discovery in the world, the Cigar Lake deposit. (See the Canada section of this Report.)

Total Compagnie Minière, the largest private mining company in France, announced in 1984 that it would begin mining two new deposits in the Massif Central region during 1985. Total currently operates two of the six active mines in France, Mailhac and St. Pierre, and owns ten percent of Rossing Uranium Ltd. in Namibia. Production from Mailhac is sold directly to EDF. The St. Pierre mine will be decommissioned in 1985 as the mine life ends.

EDF may be forced to limit slightly its nuclear power production in order to burn coal. Under a March accord with the French coal board, Charbonnages de France (CDF), EDF is committed to take as much coal as CDF decides to offer it for the next five years. Prices are to be determined by average imported coal prices or the price of nuclear-generated electricity. The agreement anticipates that CDF will deliver approximately three million metric tons of coal per year between 1985 and 1988. It is unlikely the accord will alter EDF's current construction schedule, although it could have a longer-term impact.

EDF receives most of its enrichment requirements from Eurodif, and a small amount from non-French sources (DOE and the USSR); these enrichment supplies are managed jointly with Cogema. Cogema was especially active during 1984 as the marketing agent for Eurodif, of which it is the principal shareholder. The enrichment marketing strategy that Cogema began during 1983 was an important factor in DOE's decision to offer more favorable contract terms to its customers through the USEC. Two Swiss utilities terminated DOE contracts in 1984 to enlist with Cogema. Cogema also signed contracts during 1984 with one utility in the FRG, with the Swedish State Power Board, with a Japanese utility and some US utilities, and continues to pursue business in the USA and the Far East.

In late 1984, the Commissariat a l'Energie Atomique (CEA) chose three sites for consideration as a surface storage facility for low-level nuclear waste. Existing capacity at the La Hague facility is due to be filled by 1990. CEA will narrow the options to two locations by the end of 1985, and the plant is expected to become operational by 1990.

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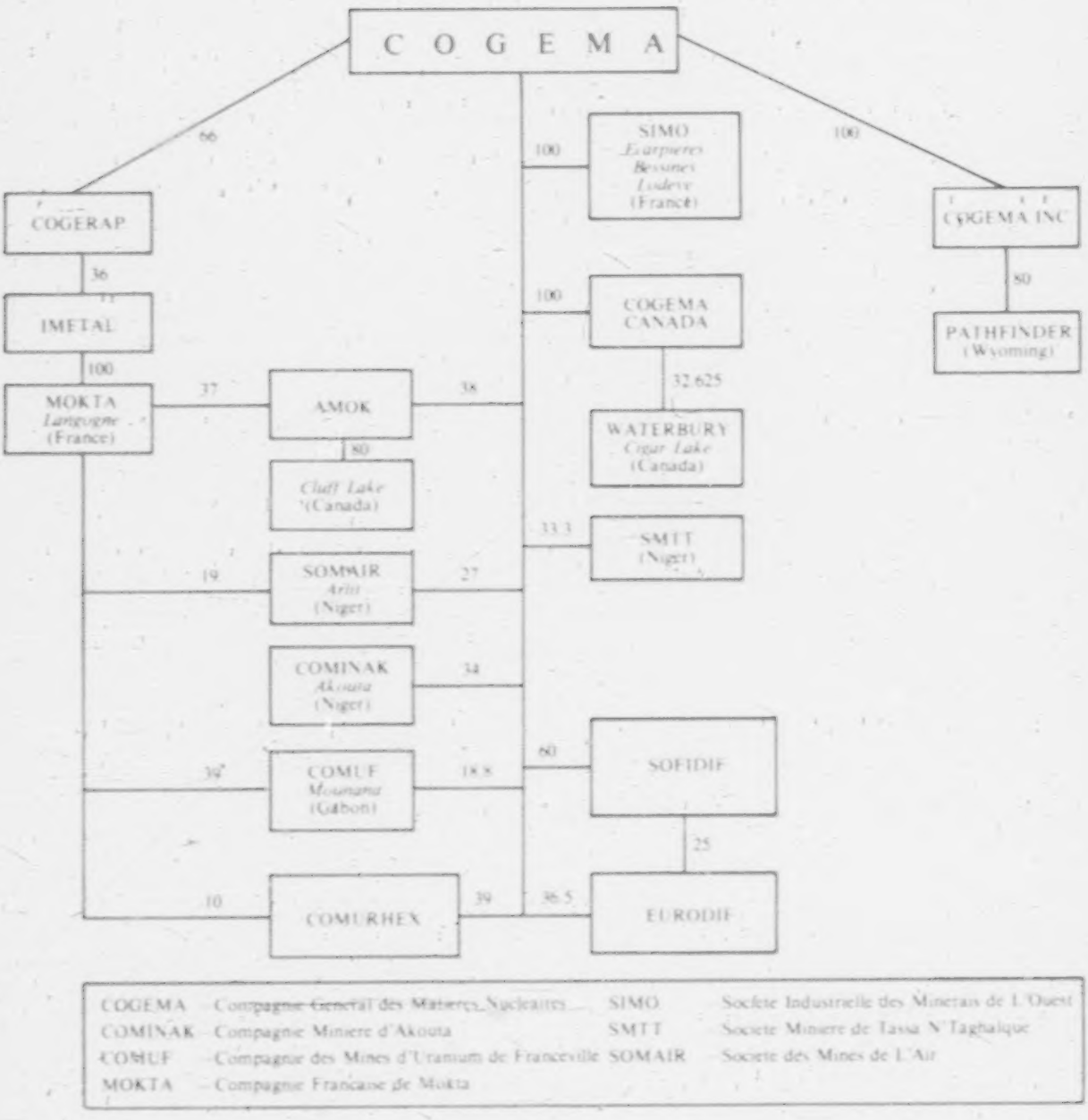

Figure 2

COGEMA OWNERSHIP INTERESTS IN WORLDWIDE URANIUM PROJECTS

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FEDERAL REPUBLIC OF GERMANY (FRG)

Electricity demand in the FRG rose 3.9 percent in 1984, and nuclear power was responsible for 27 percent of the electricity production, up from 21 percent in 1983. At the end of 1984, thirteen nuclear power units were in commercial service, with a total net installed capacity of 12,243 MWe (Table 16). Two new units entered commercial operation during the year: Kruemmel, a 1,260-MWe BWR located on the Elbe River near Hamburg (Figure 3), and the first unit of the Gundremmingen plant in Bavaria, a 1,244-MWe BWR. The Kruemmel unit is owned by HEW (Hamburgische Elektrizitaetswerke) and NWK (Nordwestdeutsche Kraftwerk). The second Gundremmingen unit was completed in 1984 and is scheduled to enter commercial operation in early 1985. Other units near commercial service include Preussenelektra's Grohnde unit, which Kraftwerk Union turned over to the wholesale utility in January 1985, and the THTR 300 (thorium high-temperature reactor) at Hamm-Uentrop. The THTR consortium, Hochtemperatur-Kernkraftwerk GmbH, hopes for approval from the state government for commercial operation in the coming weeks. (Instead of fuel rods, the THTR's core at full power contains 675,000 spheres, each consisting of one gram of high-enriched uranium and ten grams of thorium, surrounded by graphite.)

Table 16

NUCLEAR POWER UNITS IN THE FEDERAL REPUBLIC OF GERMANY

Fuel Buyer	Unit	MWe (net)	Type	COD	Percent Complete
Badenwerk, EVS[1]	Philippsburg 1	864	BWR	2/80	100
	Philippsburg 2*	1268	PWR	5/85	95
Bayernwerk	Grafenrheinfeld	1235	PWR	6/82	100
	Isar 1	870	BWR	3/79	100
	Isar 2*	1285	PWR	4/89	40
GKN[2]	GKN 1	795	PWR	12/76	100
	GKN 2*	1230	PWR	mid-1989	20
HEW[3]	Brunsbuettel	771	BWR	2/77	100
	Kruemmel	1260	BWR	3/84	100
KWO[4]	Obrigheim 1	328	PWR	3/69	100
NWK[5]	Stade	630	PWR	5/72	100
	Unterweser	1230	PWR	10/79	100
	Brokdorf*	1290	PWR	1987	65
Preussenelektra	Wuergassen	640	BWR	3/72	100
	Grohnde*	1290	PWR	6/85	100
RWE[6]	Biblis A	1146	PWR	3/75	100
	Biblis B	1240	PWR	1/77	100
	Gundremmingen B	1244	BWR	7/84	100
	Gundremmingen C*	1244	BWR	4/85	100
	Kaerlich*	1227	PWR	8/86	85
SBK[7]	Kalkar*	295	LMFBR	4/87	85
VEW[8]	THTR 300*	296	HTR	5/85	100
	Emsland*	1242	PWR	10/88	40
Total		22,910			

*Unit under construction.
[1]EVS = Energie-Versorgung Schwaben AG.
[2]GKN = Gemeinschaftkernkraftwerk Neckar.
[3]HEW = Hamburgische Elektrizitaetswerke AG.
[4]KWO = Kernkraftwerk Obrigheim GmbH.
[5]NWK = Nordwestdeutsche Kraftwerk AG.
[6]RWE = Rheinisch Westfaelisches Elektrizitaetswerk AG.
[7]SBK = Schnell-Brueter Kernkraftwerksgesellschaft.
[8]VEW = Vereinigte Elektrizitaetswerke Westfalen AG.

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Figure 3

NUCLEAR POWER STATIONS IN THE FEDERAL REPUBLIC OF GERMANY

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Under the ruling Christian Democrats, the nuclear power plant construction program in the FRG has progressed relatively smoothly in recent years. KWU has been able to achieve exceptional construction performance in several cases, most notably the standard 1,300-MWe convoy units. The Emsland unit in Lower Saxony is scheduled to be completed in under five years. Work on Isar Unit 2, brought to a costly three-month halt in 1984, is now approaching the original construction schedule. A district court in Bavaria had ordered the construction halt in January 1984 following a private suit, but the state court overruled the order shortly thereafter, limiting the work stoppage to ten weeks.

The political opposition to the utilities' power projects primarily is concentrated at the state and local levels. (There are eight states and three city-states in the FRG. Six of the states have nuclear plants.) Most utilities having units planned or under construction are highly sensitive to the results of state government elections, since the state governments may have the power to deny construction and operating licenses. Such a denial has occurred in the state of Hesse, a Green Party stronghold, where Preussenelektra has wanted for several years to build the Borken unit at the site of an important transforming junction for the national grid. The recent decision to build a reprocessing plant in Bavaria was made largely because of the relatively favorable political climate in that state.

The FRG's utilities continued to take fuel deliveries from a wide range of suppliers during 1984. The principal sources of natural uranium were Southern Africa and Australia; three West German companies own shares in Energy Resources of Australia (ERA) and several of the utilities have long-term contracts with NUFCOR in South Africa or Rossing in Namibia. Urenco, which recently completed construction on its third separative work plant at Gronau in northwest Germany (Figure 4), became the leading long-term enrichment supplier for German utilities during 1984. The German consortium Uranit (owned by Hoescht, Nukem and Preussenelektra) is a one-third partner in Urenco (Figure 5). Utilities converted only three units to the USEC (one of them being the THTR, which requires 93-percent enriched uranium for a portion of its fuel). The USSR still supplies a relatively small portion of enrichment requirements, and one utility has signed a contract with Cogema.

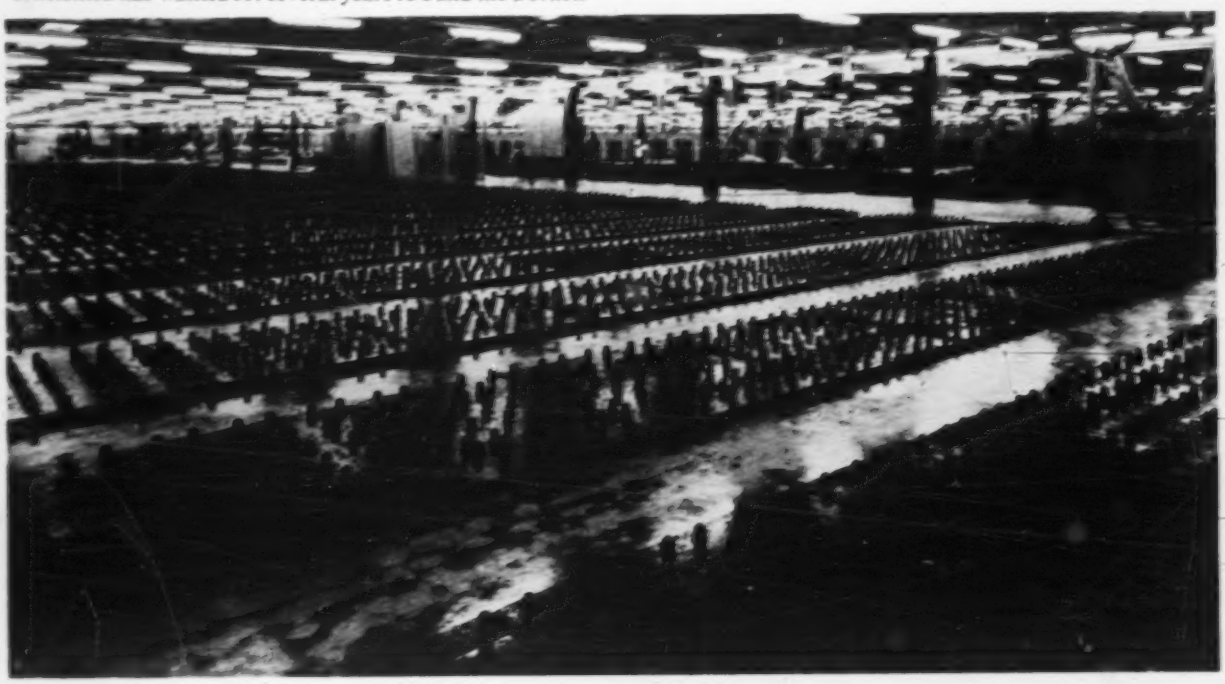

Figure 4. Urenco enrichment facility, prior to installation of centrifuges.

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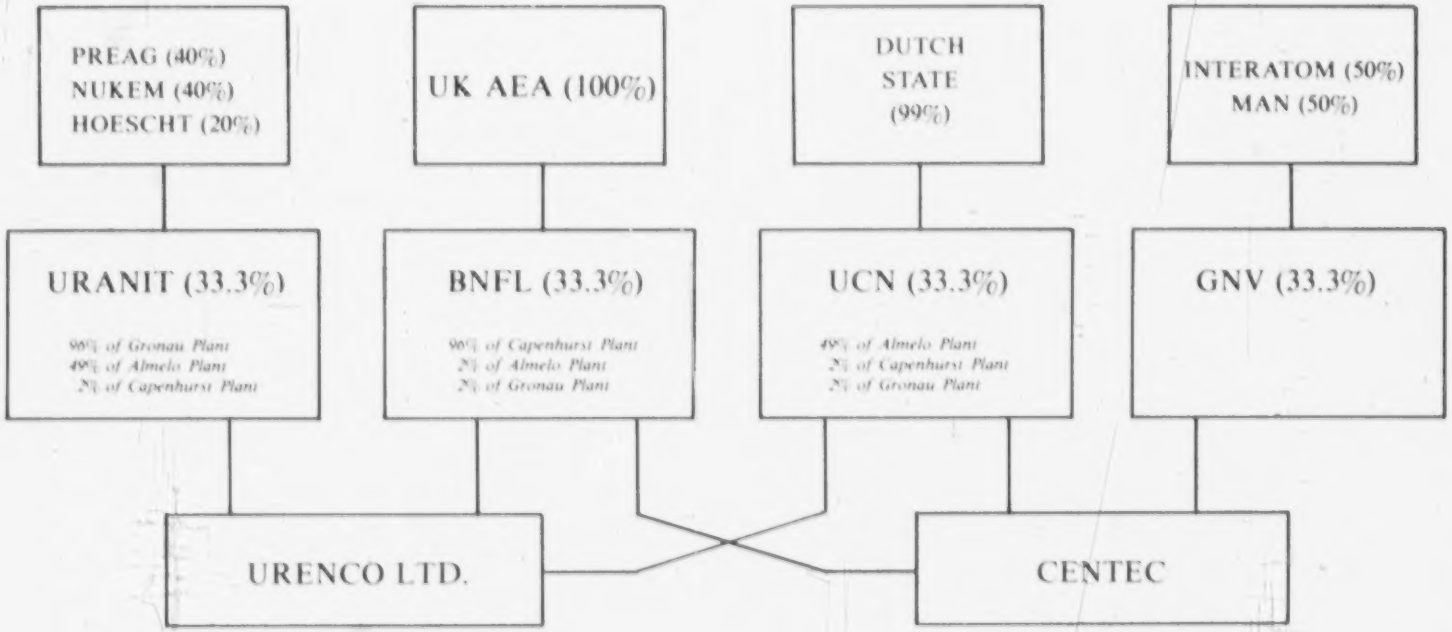

BNFL	British Nuclear Fuels Ltd. PLC	PREAG	Preussenelektra AG
CENTEC	Gesellschaft fuer Centrifugentechnik mbH	UCN	Ultra-Centrifuge Nederland NV
GNV	Gesellschaft fuer Nukleare Verfahrenstechnik mbH	UKAEA	United Kingdom Atomic Energy Authority
MAN	Maschinenfabrik Augsburg-Nuerenberg AG	URANIT	Uran-Isotopentrennungsgesellschaft mbH

Figure 5

OWNERSHIP STRUCTURE OF URENCO GROUP

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ITALY

The National Energy Plan (NEP) announced in 1981, with its ambitious plans for nuclear-generated power, has made slow progress through 1984. Over 60 percent of the nation's electricity is still generated by oil, and the NEP target of 51-percent dependence by 1990 will not be realized. A growing number of regions are becoming interested in hosting a nuclear plant, due to generous financial incentives from ENEL (Ente Nationale per l'Energia Elettrica), the state-owned utility. However, the country's nuclear plant construction program is beset with a multitude of problems and delays. Three commercially operating units generate 1,260 MWe, far below the NEP aim of 12,000-MWe capacity by 1990. Two 1,000-MWe units are under construction at Montalto di Castro, and the utility expects the units to reach commercial operation in 1988. In July 1984, the first of two reactor pressure vessels for the plant was shipped from Milan to the construction site in central Italy. Plans for six other 1,000-MW units divided between Puglia, Lombardy and Piedmont remained indefinite during much of 1984. Protracted site selection measures for the Piedmont plant took place over the course of the year, and in June ENEL submitted a study proposing two alternate sites for the two-unit plant. The regional council of Piedmont announced its decision in January 1985. The 2,000-MWe PWR plant will be built near Trino Vercellese, approximately 10 kilometers from the 270-MWe Trino unit, in operation since 1965. ENEL will act as architect-engineer during construction and as owner-operator when the plant is in service. Site preparation could begin as early as April 1985.

While the plant is under construction, the region around Trino will receive from ENEL approximately 24 billion lire (about $12 million), and will receive another six billion lire per year when the plant is in operation. The plant will be the first standardized Italian PWR based on the Westinghouse model. The cost of the nine-year project has been estimated at 3,500 billion lire ($1.8 billion).

Both ENEL and Agip SpA, the Italian state energy conglomerate, own 8.1-percent shares in Eurodif. Because the demand for enriched uranium in Italy has been limited, both companies have resold on the international market portions of their shares of Eurodif enrichment. In addition, ENEL has negotiated electricity-for-SWU agreements with Eurodif that enable it to import electricity from EDF in lieu of Eurodif enrichment services.

NETHERLANDS

Two reactors, with a total capacity of about 500 MWe, are in commercial operation in the Netherlands. The Dutch utility PZEM (Provinciale Zeeuwse Energie Maatschappij) operates the 445-MWe Borssele PWR plant. PZEM converted its abbreviated 5-year Requirements contract to the USEC for the Borssele reactor, but Urenco will assume SWU deliveries later in the decade. The Dutch company Ultra-Centrifuge Nederland (UCN) owns 33.3 percent of Urenco. In addition, one of the two Urenco enrichment facilities is located at Almelo, the Netherlands.

A heated debate over plans for the construction of more nuclear power plants captured public and governmental attention in 1984. In late 1983, a national opinion poll had indicated that over half of those interviewed openly opposed nuclear power. However, the poll was rather inconclusive in that it drew only a small fraction of Dutch voters. Nevertheless, many environmental and peace groups used this survey as justification for their efforts to discourage the ministries of economics and environment from supporting development plans as an extensive parliamentary review drew near. The ruling coalition parties (Conservative and Christian Democrat) support construction of new units, but the more populous Labor party has claimed it will attempt to block any new plants. After several postponements in December, the Dutch cabinet in January 1985 recommended the construction of 1,800 to 4,000 MW of additional nuclear generating capacity to meet anticipated electricity demand in the mid-1990s. However, it will be left to Dutch utilities to submit detailed plans, with the concurrence of local governments, subject to parliamentary approval.

The government's recommendation included provisions for the construction of at least two 900 to 1,300-MW nuclear units to provide low-cost electricity to Dutch industry in the next decade. Of six sites identified, the Borssele location was preferred. The government hopes it is possible to begin construction by early 1988 and to begin operation in 1995.

PORTUGAL

Domestic uranium production operations controlled by the Empresa Nacional de Uranio (ENU) yielded approximately 280,000 pounds U_3O_8 in 1984, a 20-percent increase over the previous year. ENU mines ore from six deposits, and the ore is milled at Urgeirica. Production could increase substantially if deposits in the Nisa district are exploited.

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SPAIN

Political Developments

After months of heated debate between utilities and the government, the Socialist Cabinet in April 1984 approved a new energy plan for the country which reduced projected nuclear capacity from 12,500 MW to 7,500 MW by 1992. The plan effectively cancels four nuclear units that were under construction and three that were planned (Table 17). Angry reactions from utilities and nuclear organizations followed the plan's announcement.

Under the plan, coal use will be promoted with the construction of eight new coal-fired plants. The government also hopes to reinforce the role of natural gas in its energy program. The nuclear energy share will rise from 2.8 percent in 1982 to 10.4 percent in 1992 with the addition of four units scheduled for operation between 1984 and 1988, but four other units already under construction have been indefinitely deferred. Those include the two Lemoniz units in the Basque region and the two Valdecaballeros units in Extremadura. In addition, three planned units have been shelved. The plan included an "automatic revision clause" which could have been implemented if energy consumption rose more than the 3.3 percent predicted by the government's plan. While consumption did in fact rise approximately five percent over the first nine months of the year, Secretary of State for Energy Martin Gallego said that the government had no intention of revising the plan unless the consumption rise turned out to be much higher.

Table 17

SPAIN'S REVISED NUCLEAR POWER PROGRAM

Unit	Utility	MWe	Type	COD
Operating				
Jose Cabrera[1]	UE[2]	160	PWR	Aug 1969
Garona	Nuclenor[3]	460	BWR	Mar 1971
Vandellos 1	Hifrensa[4]	500	GCR	Jul 1972
Almaraz 1	HE[5]/CSE[6]/UE/Iberduero	930	PWR	Aug 1981
Almaraz 2	HE/CSE/UE	930	PWR	Dec 1983
Asco 1	Fecsa[7]/Enher[8]	930	PWR	Jun 1984
Cofrentes	HE	975	BWR	May 1985
Asco 2	Fecsa/Enher	930	PWR	Jun 1985
Under Construction				
Trillo 1	UE/Iberduero	1032	PWR	Aug 1987
Vandellos 2	Enher/HC[9]	982	PWR	1987
Total		7,829		
Indefinitely Deferred				**Percent Complete**
Lemoniz 1	Iberduero	900	PWR	97
Lemoniz 2	Iberduero	900	PWR	57
Valdecaballeros 1	HE/CSE	975	BWR	52
Valdecaballeros 2	HE/CSE	975	BWR	40
Trillo 2	UE/Iberduero	997	PWR	0
Regodola	Fedeno[10]	1000	PWR	0
Sayago	Iberduero	1075	PWR	0
Total		6,822		

[1]Also known as Zorita.
[2]UE = Union Electrica.
[3]Nuclenor = Centrales Nucleares del Norte SA.
[4]Hifrensa = Hispano-Francesa de Energia Nuclear SA.
[5]HE = Hidroelectrica Española SA.
[6]CSE = Compania Sevillana de Electricidad SA.
[7]Fecsa = Fuerzas Electricas de Cataluna SA.
[8]Enher = Empresa Nacional Hidroelectrica Ribagorzana SA.
[9]HC = Hidroelectrica de Cataluna SA.
[10]Fedeno = Fuerzas Electricas del Noroeste SA.

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The Spanish Nuclear Society, which said the new plan would cause the loss of 70,000 jobs immediately, hoped the rise in consumption would trigger the revision clause so that the partially constructed plants could be completed. The government, however, must decide how to cope with the financial implications of its decision. In September, the Direction General de la Energia proposed an increase in electricity rates, including a 3.9-percent raise to fund the nuclear power cutback. The money would be distributed to the suspended projects. In addition, the Ministry for Economy suggested the levy of a special tax on electricity rates and utilities to pay for a ten-fold expansion of CSN (Consejo de Seguridad Nuclear), the nuclear safety agency.

Operating Units

The Cofrentes unit, a General Electric BWR, was connected to the grid in October 1984, bringing Spain's operating nuclear capacity to almost 5,000 MWe. The unit should enter commercial operation in early 1985. Six other units are in commercial operation. Three units are nearing completion; Asco Unit 2, a 930-MWe PWR, underwent testing in 1984 and is expected to begin operating in mid-1985. Trillo Unit 1 and Vandellos Unit 2 are scheduled to begin commercial operation in 1987 and 1988, respectively. Provided the government plan is realized, ten units having a cumulative generating capacity of 7,829 MWe will be in operation in 1992.

ENUSA, the state-owned fuel cycle services company, converted to the USEC all nine of its AFCs. A Eurodif shareholder, it had given notice to DOE for termination of its AFCs after 1992, but in negotiations in September, the two parties reached an agreement. The agreement allows ENUSA to employ its substantial inventory of DOE-enriched UF_6 prior to taking 70 percent of future requirements for nine units from DOE. Eurodif will provide enrichment for Vandellos Unit 2 and Trillo Unit 1, and may supply some portion of ENUSA's other requirements at a later date. ENUSA also has a small contract with the USSR.

Industry Ownership

At the end of 1984, after several months of bargaining, Spanish utilities agreed to a 600-billion-peseta ($3.3 billion) asset-swap maneuver, which altered the ownership structure of several nuclear units. The swap was designed to correct disparities in the market quota structure that were created by the new energy plan. Share participation in several plants, including Almaraz Unit 1, Vandellos Unit 2 and Trillo Unit 2, was redistributed among utilities. Both the government and the utilities agreed that the reorganization was necessary so that a utility's electricity production would approximate its market share.

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EUROPE

SWEDEN

Sweden's ten commercially operating reactors with 7,355-MWe generating capacity make its nuclear program the fourth largest in Europe, behind France, the United Kingdom and the Federal Republic of Germany. Nuclear power generated 41 percent of Sweden's electricity in 1984, up from 37 percent in 1983. Hydroelectric power provides almost all of the remaining electricity. Like many industrialized nations, Sweden's principal motivation for developing nuclear energy has been to reduce the percentage of energy requirements supplied by imported oil. Electricity use has grown steadily in recent years, and as nuclear and hydropower sources have been utilized, oil consumption has fallen. Oil imports now supply only 55 percent of the nation's total energy. The Swedish parliament in 1984 reaffirmed a bill calling for the continued reduction of oil use to 40 percent of total energy consumption.

Sweden's 12 units are located at four installations (Table 18). The Swedish State Power Board (SSPB), the nation's largest electrical utility, operates the four-unit Ringhals plant on the west coast. The plant is the largest nuclear power facility in the country. Ringhals Units 2, 3 and 4 are Westinghouse PWRs, the only commercial reactors in the country not supplied by Asea-Atom (the reactor vendor owned by the industrial conglomerate Asea and the Swedish government). In January 1984, all four Ringhals units, totaling 3,350 MWe, operated at 100-percent power for the first time. SSPB also is the majority owner of the Forsmark plant north of Stockholm. The utility received a fuel-loading license for Forsmark Unit 3, a 1,060-MWe BWR, in October 1984, and it expects the unit to begin commercial operation in mid-1985.

Sydkraft is the second largest utility. Its subsidiary Sydsvenska Varmekraft AB operates the two-unit Barseback plant. OKG (Oskarshamnsverkets Kraftgrupp AB), a consortium of private companies led by Sydkraft (38 percent), owns and operates the Oskarshamn plant, the site of the first commercial unit built in Sweden. All three Oskarshamn units are Asea-Atom BWRs, and the 1,050-MWe Unit 3 is scheduled to begin commercial operation in August 1985. Oskarshamn Unit 1 was the best performing reactor in Europe for the first half of 1984, achieving a

Table 18

COMMERCIAL NUCLEAR PLANTS IN SWEDEN

Unit	Utility	MWe	Type	COD[1]
Oskarshamn 1	OKG[2]	440	BWR	Feb 1972
Oskarshamn 2	OKG	595	BWR	Dec 1974
Oskarshamn 3	OKG	1050	BWR	Aug 1985
Barseback 1	Sydkraft[3]	570	BWR	Jul 1975
Barseback 2	Sydkraft	570	BWR	Jul 1977
Ringhals 1	SSPB[4]	750	BWR	Feb 1976
Ringhals 2	SSPB	800	PWR	May 1975
Ringhals 3	SSPB	915	PWR	Apr 1981
Ringhals 4	SSPB	915	PWR	Nov 1983
Forsmark 1	FKA[5]	900	BWR	Dec 1980
Forsmark 2	FKA	900	BWR	Jul 1981
Forsmark 3	FKA	1060	BWR	May 1985
Total		9,465		

[1]Actual or expected Commercial Operation Date.
[2]Sydkraft AB owns 38 percent of OKG.
[3]Sydvenska Varmekraft AB, a subsidiary of Sydkraft AB, is the owner and operator of the Barseback plant.
[4]SSPB = Swedish State Power Board.
[5]FKA = Forsmarks Kraftsgrupp AB. SSPB owns 74.5 percent of FKA and is the operator and fuel purchaser for the plant.

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93.6-percent capacity factor. When Oskarshamn Unit 3 and Forsmark Unit 3 achieve full operation and complete Sweden's current nuclear program, the nuclear portion of Sweden's electricity supply will rise to almost 50 percent.

Nuclear waste disposal and safety issues were prominent in 1984. Legislation in February replaced several laws governing waste handling and reprocessing. The 1984 Act on Nuclear Technical Activities superseded a 1977 law which prohibited fuel loading until the reactor operator has demonstrated to the government authority that high-level waste will be handled and disposed of safely. The 1977 law also required utilities to obtain reprocessing contracts before nuclear units could be licensed. The 1984 Act replaced it and several other laws, including the 1956 Atomic Energy Act, and removed the requirement to have reprocessing contracts in place. (There is still a requirement to show the capability for eventual reprocessing.) It also dictated that each reactor owner must carry out a comprehensive research and development program to ensure safe disposal of waste. In addition, the four nuclear power utilities, under the auspices of the joint company SKB (Svensk Karnbranslehantering AB), have organized several waste management projects. SFR is a subterranean facility for the permanent storage of all low and medium-level wastes. Sitework began in early 1984, and excavation began at the end of the year. The offshore facility is located near the Forsmark power plant. CLAB (Central Temporary Storage Facility for Spent Fuel) is a facility for spent fuel located in a rock cavern near the Oskarshamn plant. SKB commissioned OKG for both construction and operation of CLAB. The facility is complete and ready to receive shipments of spent fuel in early 1985. A special ship designed for the transport of spent nuclear fuel, called Sigyn, has been in operation since 1982, taking shipments for reprocessing to Cogema and BNFL. It will transport material to CLAB.

Each Swedish utility has arranged its own enrichment supply. Sydkraft converted its Requirements contracts (one 3.5-year and one 5-year) to the USEC, after having previously terminated much of its obligation to DOE in the early 1980s. SSPB did not sign the USEC, and continues to be covered by five AFC and two 3.5-year Requirements contracts for the Ringhals and Forsmark plants. OKG also did not sign the USEC, and Oskarshamn Units 1 and 2 continue to be supplied by 3.5-year Requirements contracts. The USSR will provide enrichment for Unit 3. SSPB and OKG will take long-term enrichment services from both Eurodif and Urenco later in the decade, under agreements reached in 1984.

SWITZERLAND

The 925-MWe BWR at Leibstadt, operated by Kernkraftwerk Leibstadt (KKL), achieved commercial operation in December 1984, bringing the total number of operating Swiss nuclear units to five (Table 19). The units now generate 37 percent of Switzerland's electricity. The Leibstadt plant underwent fuel loading and began testing in March 1984, and was connected to the grid in June. The Swiss government in April rejected appeals by intervenors to stay the operating license. The intervenors, from Switzerland and southern Germany, had filed a variety of complaints, using environmental and emergency planning arguments among others, which are still under review. Nevertheless, their complaints have not yet interfered with plant operations.

Table 19

NUCLEAR POWER UNITS IN SWITZERLAND

Unit	Utility	MWe	Type	COD[1]
Operating				
Beznau 1	NOK[2]	350	PWR	Dec 1969
Beznau 2	NOK	350	PWR	Mar 1972
Muehleberg	BKW[3]	320	BWR	Oct 1972
Goesgen	KKG[4]	920	PWR	Nov 1979
Leibstadt	KKL[5]	925	BWR	Dec 1984
Planned				
Kaiseraugst	KWK[6]	925	BWR	1993
Graben	KWG[7]	1,140	BWR	indefinite

[1] Actual or expected Commercial Operation Date.
[2] NOK = Nordostschweizerische Kraftwerk AG.
[3] BKW = Bernische Kraftwerk AG.
[4] KKG = Kernkraftwerk Goesgen Daeniken AG.
[5] KKL = Kernkraftwerk Leibstadt AG.
[6] KWK = Kernkraftwerk Kaiseraugst AG.
[7] KWG = Kernkraftwerk Graben AG.

A history of delays made the Leibstadt unit Switzerland's most expensive nuclear plant. Cost escalations stemmed from several problems, notably the need to install a cooling tower for the BWR after plans to use the Rhine River for cooling were blocked by the Swiss Federal Executive Council in 1971. The Council cited thermal pollution of the Rhine as the reason behind its decision. In 1973, KKL obtained permission to build the plant with a cooling tower. The plant's proximity to the border with

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EUROPE

the Federal Republic of Germany (FRG) necessitated a bilateral agreement between Switzerland and FRG for joint monitoring of the installation. The plant's ownership includes both Swiss and German interests.

The future of the last two planned reactors, Kaiseraugst and Graben, remained uncertain at the end of 1984 despite the September defeat of the anti-nuclear initiatives. The approved site for the Kaiseraugst plant, 13 kilometers from Basel, is the subject of a great deal of controversy. Basel and the surrounding regions are vigorously opposed to the plant, and voted overwhelmingly in favor of the anti-nuclear initiatives (the only region to do so). Nevertheless, the defeat of the proposals allowed the approval process for Kaiseraugst to proceed. The process had been postponed until the results of the initiatives were known. The lower house (Nationalrat) of the Swiss Parliament approved the need for the unit at the end of March 1985. Now the unit's utility, Kernkraftwerk Kaiseraugst (KWK) may start the procedure for obtaining a construction permit. Due to lengthy licensing procedures, construction probably will not begin for the next two to three years. Plans for the 1,140-MWe Graben BWR made little progress in 1984. Status of the plant remains indefinite, although the approval process might start when Kaiseraugst begins licensing and construction.

In a popular vote held September 23, 1984, the Swiss public repudiated two initiatives designed to curtail the future use of nuclear power. The rejection was a major victory for the utilities, which had mounted a formidable campaign against the initiatives, stressing the positive aspects of nuclear power. Amendments to the Swiss constitution require a double majority; that is, both a majority of the popular votes and a majority of cantons must approve the initiatives. This is significant because in the election, the popular vote was 55 percent to 45 percent against the initiatives, and 17 cantons voted against the initiatives, a true landslide. One of the initiatives, which would have imposed a moratorium of indefinite length on the construction of any power plant having a capacity of more than 35 megawatts, was rejected by 54 percent of the voters. The other initiative, proposing a "future without atomic power plants," was rejected by 55 percent of the voters. Many of the more than 50 organizations that supported the initiatives have vowed to continue their opposition, and a new drive to put another anti-nuclear initiative on the ballot has begun. However, the process, requiring the signatures of 100,000 qualified voters, usually takes at least three years and will have difficulty gaining momentum in the wake of the public mandate in September.

The Swiss utilities followed separate paths for obtaining enrichment coverage for future requirements. BKW (Bernische Kraftwerk) converted a 3.5-year Requirements contract for its operating unit (Muehleberg) to the USEC, as well as the AFC that covered the proposed Graben unit (BKW owns 45 percent of the unit). The conversion will cover 70 percent of requirements. NOK (Nordostschweizerische Kraftwerk) also converted to the USEC for one of its Beznau units, and has a contract with Urenco for the other. KKL converted its AFC to the USEC for one delivery in 1985 until a long-term contract with Cogema commences later in the year. Similarly, KKG (Kernkraftwerk Goesgen) agreed to a long-term contract with Cogema to succeed its AFC. Kaiseraugst is also covered by Eurodif.

UNITED KINGDOM

Four Advanced Gas-cooled Reactors (AGR) operated by the Central Electricity Generating Board (CEGB) entered commercial service in 1984. In addition, two units should achieve commercial operation in 1985, and four more are scheduled for operation by 1988 (Table 20). Nuclear power accounts for approximately 15 percent of the electricity generated in the UK as a whole, but in Scotland, that figure is approaching 30 percent. With the completion of the remaining AGRs by the end of the decade, nuclear power will account for 25 percent of the UK's electricity production.

The considerable progress in the implementation of the long-delayed commercial AGR program undoubtedly influenced the ongoing Sizewell inquiry. The inquiry, which began in January 1983, continued to examine the feasibility, impact and economics of the proposed Sizewell B unit, the nation's first PWR. The analysis had evolved into a general debate of the future of nuclear power in the UK, but the recent success of the AGR focused the study in later months on the wisdom of abandoning the AGR, which was developed in the UK. Final evidence was presented for the inquiry at the end of February 1985, but the Inspector's formal report regarding the PWR program is not expected until Autumn 1985. Due to the length of the inquiry, the utility delayed by 21 months the expected date for the start of construction.

A coal miners' national strike over most of 1984 threatened CEGB's primary fuel source and placed greater

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dependence on the nation's nuclear plants. The strike officially ended in March 1985, so CEGB's primary fuel supply is stable.

The British Civil Uranium Procurement Directorate (BCUPD) is responsible for supplying the natural uranium needs of the country's plants. Its five board members include one from BNFL, one from SSEB, and three from CEGB. BCUPD's mandates are administered by the British Civil Uranium Procurement Organization (BCUPO).

BCUPO took its last U_3O_8 deliveries from Namibia's Rossing mine in 1984, and has not renewed its supply contract with the producer. BCUPO still purchases material from Canadian sources. Urenco Ltd., of which BNFL owns 33.3 percent, supplies most of the enrichment needs for UK's nuclear plants. BNFL owns 96 percent of Urenco's Capenhurst plant, located in northwest England. The USSR also supplies a small portion of the UK's enrichment requirements.

Table 20

COMMERCIAL NUCLEAR UNITS IN THE UNITED KINGDOM

Station/Units	MWe net per Reactor	Type	Operating Entity	COD	Percent Complete
Calder Hall 1,2,3,4	50	GCR	BNFL[1]	1956	100
Chapel Cross 1,2,3,4	50	GCR	BNFL	1958	100
Berkeley 1,2	138	GCR	CEGB[2]	1962	100
Bradwell, 1,2	150	GCR	CEGB	1962	100
Hunterston A1,2	160	GCR	SSEB[3]	1964	100
Trawsfynydd 1,2	250	GCR	CEGB	1965	100
Hinkley Point 1,2	250	GCR	CEGB	1965	100
Dungeness A1,2	275	GCR	CEGB	1965	100
Sizewell A1,2	290	GCR	CEGB	1966	100
Oldbury 1,2	300	GCR	CEGB	1968	100
Wylfa 1,2	590	GCR	CEGB	1971	100
Hinkley Point B1	625	AGR	CEGB	1976	100
Hinkley Point B2	625	AGR	CEGB	1977	100
Hunterston B1	625	AGR	SSEB	1976	100
Hunterston B2	625	AGR	SSEB	1977	100
Dungeness B1	600	AGR	CEGB	1984	100
Heysham A1	625	AGR	CEGB	1984	100
Heysham A2	625	AGR	CEGB	1984	100
Hartlepool A1	625	AGR	CEGB	1984	100
Hartlepool A2	625	AGR	CEGB	1985	100
Dungeness B2	600	AGR	CEGB	1985	100
Heysham B1	660	AGR	CEGB	1987	70
Heysham B2	660	AGR	CEGB	1988	55
Torness Point 1	660	AGR	SSEB	1987	50
Torness Point 2	660	AGR	SSEB	1988	34
Sizewell B1	1110	PWR	CEGB	indefinite	0

[1]BNFL = British Nuclear Fuels Ltd.
[2]CEGB = Central Electricity Generating Board.
[3]SSEB = South of Scotland Electricity Board.

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YUGOSLAVIA

One commercial nuclear power plant currently is in operation in Yugoslavia. The Krsko unit, a 615-MWe Westinghouse PWR, is owned by the government utilities Savske Elektrane in Slovenia (50 percent) and Elektroprivreda in Croatia (50 percent). The unit began commercial operation in December 1981. Extensive plans for the construction of more nuclear generating facilities were announced in 1984. According to official reports, utilities are preparing to begin construction on at least five units by the end of the century, although that estimate is somewhat optimistic. Most utilities are in the earliest stages of planning, following the procedure of organizing a subsidiary to handle financing and construction of the plants. The Prevlaka plant is likely to be the next unit under construction. The utility Elektrovojvodina continued negotiations for joint-venture partners for the 1,000-MWe plant, which probably would be located in Croatia. Meanwhile, the utility explored the possibilities of beginning construction in 1988 on a plant along the Danube River in the province of Vojvodina. In addition, the Republic of Bosnia-Herzegovina in November reported plans to begin construction on a 410-MWe plant scheduled for operation in 1996. A 935-MWe plant would follow, with an operational target of 2003. At present, however, construction of only the Prevlaka plant appears likely before the end of the century.

Nuklin, the Association of Nuclear Research Institutes of Yugoslavia, in June submitted a proposal for extensive research and development in the nuclear fuel cycle. The report outlined a program covering fourteen basic projects encompassing the full range of fuel cycle services, from uranium exploration techniques to spent fuel handling. The federal government's Nuclear Energy Commission requested the study, which was aimed at promoting the attainment of a high degree of fuel cycle self-sufficiency over the next several decades. Government approval of some form of the proposal is not expected for some time.

Uranium production in Yugoslavia began in late 1984 with trial operations at a mine located at Goreije Vas in Slovenia. Construction of a mill at the Zirovski Vrh mine site was completed in August 1984. The mill, designed by Fluor Mining and Metal Company, underwent plant inspections in July and August, and was targeted to produce 30 metric tons uran... n by the end of 1984. Full production levels should be achieved by 1986. It has a throughput capacity of 210,000 metric tons of ore per year. The Zirovski Vrh mill is expected to supply U_3O_8 destined for refueling of the Krsko power plant. For its enrichment needs, Krsko signed the USEC for its only unit.

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JAPAN

Introduction

The progress of Japan's nuclear industry in 1984 was highlighted by several significant accomplishments and other events.

1. Three nuclear power plants began commercial operation, increasing Japan's utilities' total nuclear generating capacity by 2,514 MWe, to a total of 19,691 MWe. Four additional facilities, comprising a total of 3,940 MWe, reached criticality and will begin commercial operation in 1985.

2. Siting problems for future commercial enrichment and reprocessing facilities were resolved. In a unique approach to the siting problem, the utilities have proposed building the plants at a common location, along with another facility for centralized long-term storage of low-level radioactive wastes from nuclear plants.

3. The utilities concluded negotiations with the US DOE to reorganize their supplies of enrichment services by means of the Utility Services enrichment contract (USEC).

Operating Nuclear Plants

Table 21 summarizes the current status of operating nuclear generating facilities for Japan's utilities. Twenty-eight plants with a total capacity of 20,561 MWe constitute approximately 15 percent of Japan's total electrical generating capacity. Nuclear power accounted for more than 20 percent of total electricity generated in 1984.

Three plants which achieved criticality in 1983 attained commercial operation in 1984. Fukushima II Unit 2 (a 1,100-MWe BWR); Onagawa Unit 1 (a 524-MWe BWR); and Sendai Unit 1 (an 890-MWe PWR). In addition, three plants loaded fuel in 1984 and, after testing, will enter commercial operation in 1985; Takahama Un. 4 (an 870-MWe PWR); Fukushima II Unit 3; and Kashiwazaki Unit 1 (both 1,100-MWe BWRs). Takahama Unit 3, an 870-MWe PWR, began commercial operation in January 1985. The Fukushima plant is the sixth of ten BWRs Tokyo Electric Power Co. will operate at that site. Kashiwazaki Unit 1 is the first of five BWRs (and possibly more) to be located at a common site. In 1984, the 27 operating plants had an average capacity of 72.3 percent, the third year in a row in which Japan's nuclear plants have achieved an average capacity factor greater than 70 percent.

Until 1984, nuclear generating costs in Japan showed an apparent advantage over fossil fuel and hydroelectric generation facilities. In 1984, however, increases in nuclear plant construction costs, combined with relatively stable fossil fuel prices, narrowed the cost differentials. Table 22 compares plant and generating costs for various types of electrical generating facilities. Nuclear generation costs do not include future plant decommissioning or long-term waste disposal costs. Inclusion of such factors would result in almost identical costs for nuclear power and coal power.

The Japanese Ministry of International Trade and Industry (MITI) estimated the cost information presented in Table 22 based on generation facilities which began in 1984, using designs and sizes which are believed to reflect the current state of technology, and estimating 70 percent plant availability. In a late 1984 report, MITI reaffirmed government policy to continue emphasizing nuclear generation. MITI expected eventual increases in fossil fuel prices, and cited the need for delivery of fuel supply. Further, it noted that one reliable way of stockpiling fuel consisted of loading fuel into a nuclear reactor.

Plant Construction and Licensing

Four nuclear power plants obtained establishment permits (combined construction and operating licenses) in 1984. (See Report 168 for a discussion of Japan's nuclear plant licensing procedure.) Hokkaido Electric Co. received the permits for its Kyowa-Tomari Units 1 and 2 (both 579-MWe PWRs) and started construction. Kyushu Electric Co. received permits for its Genkai Units 3 and 4 (1,180-MWe PWRs) and will start construction in August 1985 following receipt of pending local construction permits.

In addition, Tokyo Electric Power announced its intention to proceed with two additional 1,100-MWe BWRs, Kashiwazaki Units 3 and 4, with expected operation dates of 1993 and 1994, respectively. Kansai Electric disclosed plans to expand its current Ohi site with the addition of two 1,180-MWe PWRs, Ohi Units 3 and 4. Commercial operation has been scheduled tentatively for 1991 and 1992, respectively. Initial public hearings for these four plants have been held, and as of February 1985, Ohi Units 3 and 4 achieved actual project status and are undergoing licensing. Table 23 summarizes the status of officially recognized nuclear plant projects in Japan.

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FAR EAST

Table 21

COMMERCIALLY OPERATING NUCLEAR POWER PLANTS IN JAPAN

Unit	Utility	Capacity (MWe net)	Type	Commercial Operation
Tokai 1	JAPC[1]	166	GCR	Jul 1966
Tsuruga 1	JAPC	357	BWR	Mar 1970
Mihama 1	Kansai EPC[2]	340	PWR	Nov 1970
Fukushima I-1	Tokyo EPC	460	BWR	Mar 1971
Mihama 2	Kansai EPC	500	PWR	Jul 1972
Shimane 1	Chugoku EPC	460	BWR	Mar 1974
Fukushima I-2	Tokyo EPC	784	BWR	Jul 1974
Takahama 1	Kansai EPC	826	PWR	Nov 1974
Genkai 1	Kyushu EPC	559	PWR	Oct 1975
Takahama 2	Kansai EPC	826	PWR	Nov 1975
Fukushima I-3	Tokyo EPC	784	BWR	Mar 1976
Hamaoka 1	Chubu EPC	540	BWR	Mar 1976
Mihama 3	Kansai EPC	826	PWR	Dec 1976
Ikata 1	Shikoku EPC	566	PWR	Sep 1977
Fukushima I-5	Tokyo EPC	784	BWR	Apr 1978
Fukushima I-4	Tokyo EPC	784	BWR	Oct 1978
Tokai 2	JAPC	1100	BWR	Nov 1978
Hamaoka 2	Chubu EPC	840	BWR	Nov 1978
Ohi 1	Kansai EPC	1175	PWR	Mar 1979
Fukushima I-6	Tokyo EPC	1100	BWR	Oct 1979
Ohi 2	Kansai EPC	1175	PWR	Dec 1979
Genkai 2	Kyushu EPC	559	PWR	Mar 1981
Ikata 2	Shikoku EPC	566	PWR	Mar 1982
Fukushima II-1	Tokyo EPC	1100	BWR	Apr 1982
Fukushima II-2	Tokyo EPC	1100	BWR	Feb 1984
Onagawa 1	Tohoku EPC	524	BWR	Jun 1984
Sendai 1	Kyushu EPC	890	PWR	Jul 1984
Takahama 3	Kansai EPC	870	PWR	Jan 1985
TOTAL MWe		20,561		

[1]JAPC = Japan Atomic Power Company
[2]EPC = Electric Power Company

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Nuclear Generation Forecasts

MITI, which is responsible for the government's policy regarding the establishment of objectives (for planning purposes) for future electrical generation, with support from related private sector advisory bodies, reaffirmed in 1984 the revised nuclear generating capacity forecasts:

FY1990: 34,000 MWe Installed
FY1995: 48,000 MWe Installed
FY2000: 62,000 MWe Installed

Based on the status of plants under licensing or under construction as indicated in Table 23, along with their current estimated operating dates, Nuexco projects that approximately 33,000 MWe of capacity will be in commercial operation by 1990. Combining the units listed in Table 23 with currently operating plants (Table 21) totals 36,000 MWe of capacity (including firmly committed projects with operation dates through 1994). Thus, if the MITI target of 48,000 MWe installed capacity by 1995 is to be achieved, Japan's utilities will need to add 12,000 MWe of planned capacity to current plants now undergoing licensing procedures. Based on the status of future projects as well as possible delays to current projects and new site development, Nuexco estimates Japan's utilities will add about half that much, reaching approximately 41,000-42,000 MWe installed capacity by 1995. Some future significant downward revision also can be expected for the MITI target for the year 2000.

Uranium Inventories

Japan's utilities received deliveries of approximately 22 million pounds of uranium in 1984. About 80 percent of the total arrived under long-term contracts completed in the 1970s with overseas suppliers at a time when government nuclear generation targets and utilities' plant schedules were optimistic. As late as 1979, plans targeted 33,000 MWe operating by 1985 (approximately equal to the present target for 1990). With four plants scheduled for commercial operation in 1985, the actual total will be 23,600 MWe.

Because actual needs represented only 60 to 70 percent of 1984 uranium deliveries, the Japanese utilities added approximately 8 to 9 million pounds equivalent U_3O_8 to inventory. Nuexco estimates that the utilities collectively hold *excess* inventories of about 55-60 million pounds equivalent U_3O_8 in various forms. (The term *excess inventories* means that amount by which cumulative deliveries to date exceed initial core and reload fuel requirements for reactors currently operating or under testing.) Under existing supply contracts, future deliveries to Japanese utilities will average about 15 million pounds of U_3O_8 per year through the mid-1990s. The majority of Japanese utilities currently hold excess inventory ranging from five to ten years' forward supply, although several have much smaller stockpiles. Based on current inventories, additional future deliveries, and a possible lowering of generation targets for 1995 and beyond, Nuexco estimates that

Table 22

1984 ELECTRICAL GENERATING COSTS IN JAPAN[1]

Source	Net Generation Cost[2] yen/KWh	(¢/KWh)	Approximate Fuel Cost as % of Net Generation Cost	Current Plant Construction Cost yen/KW	($/KW)
Hydro	21	(8.8)	—	630,000	(2,625)
Oil	17	(7.1)	75	140,000	(583)
Coal	14	(5.8)	45	240,000	(1,000)
Liquid Natural Gas	17	(7.1)	65	190,000	(791)
Nuclear	13	(5.4)	25	310,000	(1,292)

[1]Costs converted from Japanese yen to US dollar at approximate rate of 240 yen/dollar.
[2]Does not include transmission and distribution costs.

Source: Ministry of International Trade and Industry.

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the Japanese utilities are amply supplied with uranium at least through the mid-1990s.

With few exceptions, it is likely that Japanese utilities will be relatively inactive in the uranium market for several years. (One new supply contract and the extension of another were announced in early 1985.) Because most commitments are established by long-term contracts, the major activity will be the annual negotiation of prices for the following year's deliveries. Most deliveries in 1984 were in the range of $34-38 per pound U_3O_8. In late 1984, preliminary negotiations for most 1985 deliveries tentatively were concluded at $33-34 per pound.

Enrichment

The negotiations of the DOE Utility Services enrichment contract (USEC) for supply of enrichment services was a major event for the Japanese utilities in 1984. The nine private utilities and the Japan Atomic Power Corporation, which held primarily Adjustable Fixed Contracts (AFCs) and a small number of Requirements-type Contracts with DOE, all converted to the USEC. Of the utilities, the majority converted to 100 percent of requirements from DOE. Four utilities (Chugoku, Hokkaido, Shikoku, and Tohoku Electric) elected to receive 70 percent of requirements. Because the Japanese utilities represent about 20 percent of DOE's total market, DOE viewed the Japanese response as a major accomplishment.

It appears the USEC contracts negotiated by each utility with DOE incorporated numerous special concessions for their Japanese customers, but details have yet to be disclosed. DOE's willingness to accommodate probably stemmed from a combination of factors specific to Japan.

Table 23

JAPANESE NUCLEAR POWER UNITS
UNDERGOING CONSTRUCTION AND UNDERGOING LICENSING

Unit	Utility	Capacity (MWe net)	Type	Estimated Commercial Operation
Under Construction				
Fukushima II-3	Tokyo EPC[1]	1100	BWR	Jul 1985
Takahama 4	Kansai EPC	870	PWR	Aug 1985
Kashiwazaki 1	Tokyo EPC	1100	BWR	Oct 1985
Sendai 2	Kyushu EPC	890	PWR	Mar 1986
Tsuruga 2	JAPC[2]	1160	PWR	Jun 1987
Hamaoka 3	Chubu EPC	1100	BWR	Sep 1987
Fukushima II-4	Tokyo EPC	1100	BWR	Sep 1987
Shimane 2	Chugoku EPC	820	BWR	Sep 1988
Kyowa Tomari 1	Hokkaido EPC	579	PWR	Jun 1989
Kashiwazaki 5	Tokyo EPC	1100	BWR	Apr 1990
Kashiwazaki 2	Tokyo EPC	1100	BWR	Oct 1990
Kyowa Tomari 2	Hokkaido EPC	579	PWR	Jun 1991
Genkai 3	Kyushu EPC	1180	PWR	Mar 1993
Genkai 4	Kyushu EPC	1180	PWR	Mar 1994
Undergoing Licensing[3]				
Ikata 3	Shikoku EPC	890	PWR	Oct 1990
Maki 1	Tohoku EPC	825	BWR	Mar 1994
TOTAL MWe		15,573		

[1]EPC = Electric Power Company
[2]JAPC = Japan Atomic Power Company
[3]Kansai EPC's Ohi Units 3 and 4 began licensing procedures in February 1985.

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1. Japan plans to build enrichment facilities for operation in the 1990s which ultimately would supply about 20 percent of total domestic utility needs.

2. Existing enrichment supply from Eurodif amounts to approximately one million SWUs annually to the private utilities under contracts extending through 1979, and those contracts could be extended.

3. About four million prepaid DOE SWUs remained undelivered. These SWUs represent the balance of the eight million SWUs paid for in advance by the Japanese utilities more than a decade ago at prevailing prices. At the time, the deliveries were prepaid in order to aid the Japanese government in efforts to reduce the trade imbalance between the USA and Japan.

4. The utilities currently hold large inventories of enriched uranium arising from SWU deliveries under previous AFC contracts, so the prospect of some relief from future deliveries was quite appealing to the Japanese.

Both Eurodif and Urenco marketed aggressively to the Japanese utilities in 1984. Utility involvement in USEC negotiations created an obstacle to those efforts. Moreover, DOE's indications that it probably would make offers of reduced-price SWU in the spring of 1985 compounded marketing difficulties for the non-US enrichers. As a result, utility managements chose to defer decisions until the realities of DOE's price reductions could be discerned. Urenco has not been successful in Japan to date. Eurodif has negotiated a significant extension of its supply contract to one Japanese utility, and is likely to obtain additional extensions with several other utilities.

From mid-1984 the Japanese utilities, via their coordinating organization, the Federation of Electric Power Companies (FEPC), took a major step in promoting Japan's move toward domestic commercial enrichment capability. The FEPC proposed the following, subject to local and national government approvals:

1. Construction of an enrichment facility capable of producing 150,000 SWU annually by 1991, with progressive expansion to 1.5 million SWU annual capacity by 1997. The latter capacity would equal approximately 20 percent of utilities' total needs in 1997. Current estimates place the facility cost at the equivalent of US $600 million.

2. The plant will use centrifuge technology developed by Power Reactor and Nuclear Fuel Company (PNC), a government-affiliated organization. PNC has developed and proven such technology as part of a government-sponsored national program which began in the early 1970s (see Report 189).

3. In a unique arrangement which resolves siting problems, the enrichment facility will be located adjacent to a commercial spent-fuel reprocessing facility and a central plant for storage of low-level radioactive wastes from the utilities' nuclear plants. The common site for the three facilities would be in the northern part of Japan's main island of Honshu, at a site designated as Rokkasho-mura.

4. The private utilities, with participation from about forty other companies associated with the nuclear industry, agreed to organize a new company (incorporated in March 1985) called Japan Nuclear Fuel Industries (JNFI). JNFI will build, own, and operate both the enrichment facility and central waste storage facility.

Following the FEPC proposal, organizers have begun the preparatory work, which appears to be on schedule. In addition, the three nuclear vendors which manufactured the centrifuge machines for PNC's enrichment development program (Hitachi, Toshiba, and Mitsubishi Heavy Industries) have organized a new company, Uranium Enrichment Machinery Co. (UEM), to fabricate centrifuges for JNFI's facility, as well as for PNC's continuing programs. For commercial demonstration of its technology, PNC is constructing an enrichment plant which is scheduled to produce 100,000 SWU per year by 1987, expanding to 200,000 SWU per year in 1988. UEM's initial annual production in 1986 will consist of the number of cascades needed to produce 100,000 SWU per year. Eventually UEM will fabricate enough centrifuges annually to produce 300,000 SWU per year.

Reprocessing

Since 1977, PNC has operated a 0.7-ton-per-day reprocessing plant based on European reprocessing technology. The plant was designed to demonstrate technology and serve as a basis for a commercial-scale domestic reprocessing facility. Although largely successful, the plant has been plagued by numerous mechanical problems, and as of the end of 1984 had processed less than 200 tons of spent nuclear fuel from domestic nuclear plants. In the interim, several utilities have processed nominal quantities of spent fuel via service contracts with European suppliers. However, most spent fuel discharged from reactors has been stored by the Japanese utilities in storage pools at the plant sites.

Establishing a commercial-scale domestic reprocessing capability has been a topic of discussion for the past decade, and in 1980, Japanese utilities organized Japan Nuclear Fuel Services (JNFS) for just such a purpose. Various plant proposals evolved, but JNFS encountered problems in finding an acceptable location. The recent FEPC announcement to locate the plant adjacent to planned enrichment and waste storage facilities elimi-

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nated the last apparent major obstacle to commercial domestic reprocessing.

As part of the above joint siting, FEPC indicated JNFS would proceed with an initial spent-fuel storage facility capable of storing 3,000 tons of spent fuel by 1991. The facility would provide relief for the storage facilities at individual nuclear plant sites which have been accumulating increasing amounts of fuel. A reprocessing facility with an annual capacity of 800 tons of spent fuel will be completed by 1995, and provisions will allow for future expansion. Initial plant cost is estimated to be the equivalent of US $3.0 billion.

Other Reactor Types

For more than 15 years, the Japanese government and private industry have undertaken joint development of other reactor types as alternatives to the current commercial LWR program. PNC successfully demonstrated fast breeder reactor (FBR) technology by operating a 75-MW (thermal) FBR in the late 1970s. A 280-MWe demonstration FBR scheduled for completion by PNC in 1985 was to follow the project. However, because of licensing, funding and organizational delays, completion now is scheduled for the early 1990s. Plans made in 1984 called for a joint conceptual study by PNC and the utilities to decide by 1987 on the status of a commercial-scale (1,000-MWe) demonstration FBR. Construction would begin following completion of the 280-MWe FBR. Long-range plans call for an actual commercial FBR to be operational by the year 2010, with a cost objective that the plant should not exceed 1.5 times the cost of an LWR of the same capacity.

PNC also has successfully operated since 1979 an advanced thermal reactor (ATR) with 165-MWe capacity. The ATR is a heavy-water-moderated, light-water-cooled reactor fueled with slightly enriched uranium. In 1984, it was decided that PNC would transfer its ATR expertise to the Electric Power Development Company (EPDC), another government-affiliated company which has undertaken a large portion of Japan's hydroelectric projects to date. EPDC will design and construct a 600-MWe commercial demonstration ATR with license application scheduled for 1986, and construction completion scheduled for the early 1990s. The plant's location will be in northern Honshu, not far from the private utilities' planned enrichment, reprocessing, and waste storage facilities.

Both the FBR and ATR are part of a national development program established in 1967. Program objectives included the reduction of utilities' needs for natural uranium (for which Japan is dependent on overseas suppliers) by recycling plutonium and depleted uranium. Participants viewed the ATR as an intermediate step leading to the full-scale replacement of LWRs with FBRs as Japan's basic commercial reactor. Initial planning for such a program would have permitted recycling in the 1990s. Current status indicates that the program, if viable, will probably not materialize until well into the next century. Current plans also call for the use of mixed oxide fuels in LWRs, and some test programs have been implemented. It appears, however, that LWRs using enriched uranium fuel will continue to be the basis for nuclear generation in Japan for the next several decades.

PEOPLE'S REPUBLIC OF CHINA (PRC)

The People's Republic of China announced the undertaking of an ambitious nuclear program in 1984. The outline of the program includes development of nuclear power in eastern and southern provinces with an eventual generating capacity of 2,000 MWe by 1990 and 10,000 MWe by 2000. Based on the history of development of nuclear power programs in other countries, such a plan, which involves the operation of 10 to 12 pressurized water reactors (PWRs) by year 2000, is quite optimistic.

The PRC signed several technical and commercial agreements with various countries in 1984. These included the following:

1. A joint agreement with the Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan for uranium exploration;
2. An agreement with Bechtel of the USA for the formation of a joint company (China American International Engineering);
3. An agreement with Klein, Schauzlin and Becker AG from the Federal Republic of Germany for main coolant pumps;
4. An agreement with the Comax Buffalo Corporation from the USA for containment penetration;
5. An agreement with Mitsubishi Heavy Industries from Japan for a PWR pressure vessel. The French company Framatome may be awarded a sizable part of the work on the first PWRs to be built in the Quandong Province as part of the Daya Bay Project.

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THE PHILIPPINES

The only nuclear power plant in the Philippines, Bagac San Juan Unit 1 (also known as Philippines National Power Plant 1, PNPP-1), officially is scheduled to begin commercial operation in the first quarter of 1985. However, a test run initially scheduled in September 1984 did not take place, and the issuance of an operating license still is pending. The Ministry of Energy had predicted that the Philippines' oil-importing bill would decline from $1.5 billion in 1984 to $1.2 billion in 1985. This is a result of economic slowdown as well as startup of the 600-MWe nuclear plant, a 300-MW coal-fired plant, and two 110-MW geothermal plants.

In anticipation of the nuclear plant operation, the Philippines National Power Corporation remains in the market for purchase of enriched uranium in 1984 and natural uranium in early 1985.

SOUTH KOREA

The Korea Electric Power Corporation (KEPCO) completed the construction of its fourth nuclear plant in 1984, Ko-Ri Unit 5, an 895-MWe PWR designed by Westinghouse (Table 24). The plant, located on the southwest coast of Korea, underwent test runs in January 1984 and is expected to begin commercial operation in March 1985.

However, the recent government program indicates that two units initially scheduled for operation in 1993-1994 may have been delayed for several years. As a result, international bidding for Korea Nuclear Units 11 and 12 may not be initiated before 1986.

Korea also announced its intent to build its own fuel fabrication plant for commercial production in the 1990s, which will be sufficient for KEPCO's planned programs. The plant eventually would be controlled by KEPCO and the Korea Advanced Energy Research Institute (KAERI). KEPCO considered participation by some foreign interests, but later rejected the plan. The plant will be built near Taejon, south of Seoul, with a capacity of 200 MTU per year. The US Export-Import Bank has agreed to provide 85 percent of the financing if a US vendor is awarded the contract for the project.

In general, Korea seeks to increase the degree of autonomy and self-sufficiency in its nuclear program. The Korea Power Engineering Corporation (KOPEC), an engineering subsidiary of KEPCO, is promoting the development of local architect-engineering capability through joint ventures and agreements with overseas companies. KEPCO also manages and partially owns Korea Heavy Industries and Construction (KHIC), and is helping KHIC to localize the construction of all major hardware components by the end of the 1980s. KHIC, as the sole designated Korean manufacturer, is the umbrella licensee to the main supplier companies abroad. KHIC hopes to award subcontracts in the future to smaller Korean companies.

For Korea, 1984 was a year of readjustments in its nuclear power program. Three factors explain the readjustments:

1. The slowdown of economic growth in recent years and the consequent decline in electricity demand growth;
2. The drop in oil prices, which has made less urgent the need to cut dependence on oil;
3. The government's desire to reduce the foreign debt.

Table 24

NUCLEAR POWER UNITS IN SOUTH KOREA

Unit	Plant	MWe	Type	COD[1]	Percent Complete
KNU 1	(Ko-Ri)	556	PWR	4/78	100
KNU 3	(Wolsung)	629	Candu	4/83	100
KNU 2	(Ko-Ri)	605	PWR	7/83	100
KNU 5	(Ko-Ri)	895	PWR	6/85	96
KNU 6	(Ko-Ri)	895	PWR	3/86	88
KNU 7	(Yeonggwang)	900	PWR	12/86	82
KNU 8	(Yeonggwang)	900	PWR	9/87	72
KNU 9	(Ul-Jin)	895	PWR	9/88	37
KNU 10	(Ul-Jin)	895	PWR	9/89	31

[1] Actual or expected Commercial Operation Date

TAIWAN

The Taiwan Power Company (Taipower) increased its number of operating nuclear plants to five in 1984 when the first Maanshan unit began commercial operation (Table 25). Maanshan Unit 1, a 907-MWe pressurized water reactor (PWR) designed by Westinghouse, is located at the southern tip of Taiwan. The second Maanshan unit is scheduled to begin operation in 1985. There were indications in 1984 that Taipower had revived plans to build their seventh and eighth units at a new plant site, Yenliao, scheduled for operation in the early 1990s. Taipower ex-

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pected bid invitations from General Electric, Westinghouse, Combustion Engineering, Framatome and Kraftwerk Union. However, recent political developments indicate that plans have not passed all the levels of approval in Taiwan.

Negotiations for a joint venture agreement between Taipower and Rocky Mountain Energy for an exploration program in the USA also were announced in 1984. The announcement may have been premature because the required government approvals for such an agreement have not been released yet.

Unlike the situation in Korea and Japan, the desire to develop complete domestic nuclear engineering capability has not been pronounced in Taiwan. All of the operating reactors and most of the nuclear technology have come from the USA. However, Taipower has a strong construction division and generally works closely with US architect-engineering firms, notably Ebasco and Bechtel. All of the civil engineering responsibilities are handled by local companies.

Table 25

NUCLEAR POWER UNITS IN TAIWAN

Unit	MWe	Type	COD[1]	Percent Complete
Chin-Shan 1	604	BWR	Dec 1978	100
Chin-Shan 2	604	BWR	Sep 1979	100
Kuosheng 1	951	BWR	Dec 1981	100
Kuosheng 2	951	BWR	Mar 1983	100
Maanshan 1	907	PWR	Jul 1984	100
Maanshan 2	907	PWR	May 1985	95

[1] Actual or expected Commercial Operation Date

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REPUBLIC OF SOUTH AFRICA

Overview

South Africa's gold and uranium operations experienced a relatively prosperous year in 1984 largely because of a favorable rand/dollar exchange rate. Although mines received lower dollar prices for both gold and uranium in 1984, the strength of the US dollar brought about increased rand revenues for producers.

Political difficulties in South Africa were eased somewhat with the March signing of a Non-Aggression Accord with neighboring Mozambique. Contact and trade are taking place despite the opposing economic and political systems. Seen by South Africans as a major foreign policy breakthrough, the Accord has opened the door for a wide-ranging reduction of international confrontation. South African troops are withdrawing from Angola, and peace discussions for Angola and Namibia are proceeding. Nevertheless, South Africa faced increased international opposition to its apartheid policies in 1984. That issue maintains its worldwide prominence and will continue to present obstacles to South African producers' marketing efforts.

Nuclear Power

The Electricity Supply Commission of South Africa (Escom) connected the nation's first commercial nuclear power plant to the electrical grid on April 4, 1984. Koeberg Unit 1, a 922-megawatt PWR, was supplied by the French companies Framatome, Alsthom-Atlantique and Framateg. Framatome announced on August 20 that the unit began commercial operation after receiving authorization from the South African Atomic Energy Corporation at the beginning of August. (The unit was subsequently shut down on January 25, 1985 for cooling pipe inspections.) The French reactor vendor added that Koeberg Unit 1 produced over 1.5 billion kilowatt-hours between April and the end of August. Koeberg Unit 2, also a 922-MW PWR, currently is undergoing power testing, and Nuexco estimates that it will begin commercial operation in late 1985. The Koeberg units are likely to be the only commercial nuclear power plants in South Africa for the rest of the century, as declining growth rates for electricity demand and low coal costs have postponed the need for more nuclear generation.

In February 1984, DOE suspended Escom's two enrichment contracts because of a lingering dispute over nonproliferation safeguards. The US State Department requested the suspension following an announcement by South Africa's Atomic Energy Corporation that it would require safeguards as a condition of exporting nuclear material or technology. Escom has been unable to export enriched product from the USA because of certain provisions in the Nuclear Nonproliferation Act of 1978 which pertain to non-weapons states. The suspension of the contracts allowed South Africa to avoid purchasing enrichment far in excess of its needs, while relieving the US State Department of embarrassment stemming from a possible breach of contract by a US government agency.

Uranium Production and Resources

The South African uranium industry experienced another profitable year, mainly due to favorable currency exchange rates. While mines received lower US dollar prices for uranium and gold, the dramatic depreciation of the rand relative to the dollar resulted in record gold prices in rand terms. Since most of the uranium mined in South Africa is extracted as a by-product or co-product of gold operations, the uranium industry was assured a successful year. Table 26 shows a breakdown of uranium production among the thirteen Chamber of Mines operations in South Africa during 1984. Palabora Mining Company (PMC) is not a Chamber of Mines member. Total production in 1984 of 14,531,000 pounds U_3O_8 was five percent less than 1983. Eight producers experienced declines in production totalling approximately 1.2 million pounds, over 60 percent of which was attributed to Harmony, JMS, and Beisa. This decline was partially offset by increases in production by three producers amounting to approximately 450 thousand pounds. Randfontein and Vaal Reefs contributed 90 percent of the increase.

Palabora Mining Company announced in its annual report to shareholders that it sold 502 thousand pounds of uranium concentrates in 1984. This represents a 29-percent increase from the 356 thousand pounds sold in 1983. PMC has not yet released exact production figures.

NUCOR (the Nuclear Development Corporation of South Africa) in August released an updated official assessment of South Africa uranium resources and production capabilities. The report included the latest official evaluation of trends in uranium prospecting, production and prices, as well as discussions of geology and national policy matters.

NUCOR estimated that total Reasonably Assured Resources (RAR) and Estimated Additional Resources (EAR) recoverable for less than $130 per KgU declined

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13.4 percent compared to the 1981 assessment. NUCOR also concluded that 1983 South Africa production rose 4.2 percent from 1981 production figures. (The NUCOR report is examined in greater detail in Report 193, September 1984.) Other findings included the following:

1. South Africa supplied 14 percent of the free world's uranium in 1983.

2. The country also holds 14 percent of the free world's resources.

3. The Witwatersrand quartz-pebble conglomerates are the basis of 97 percent of South Africa's production; the Palabora project produces the remaining three percent as a by-product of copper mining.

Specific Comments on Production Operations

Beisa (St. Helena). Total production fell 21 percent in preparation for the cessation of operations scheduled for late 1984. Third and fourth quarter production amounted to only 37 percent of the first and second quarter levels. General Mining Union Corporation Limited (Gencor) and St. Helena Gold Mines Limited announced on May 1 their intention to shut down the mine in late 1984 because of sharply increasing losses. Beisa had been unprofitable since production began in 1982. Because of a lower than expected recovery grade, St. Helena purchased uranium from other sources in order to meet contractual obligations. NUFCOR (Nuclear Fuels Corporation of South Africa [Proprietary] Limited) has agreed in principle to accept assignment of all obligations under the 1978 uranium supply agreement. Proceeds from the sale of assets are expected to cover the major portion of liabilities relating to the mine. Because profitable operation of the mine is unlikely in the near future, it was not placed on a care and maintenance basis, but was completely shut down. Being a primary uranium producer with gold as a by-product, Beisa had not been able to rely on gold operations to remain profitable. Its demise will reduce South Africa's annual production rate by approximately 1,000,000 pounds U_3O_8.

Blyvooruitzicht. This relatively high-cost producer

Table 26

REPUBLIC OF SOUTH AFRICA:
1984 URANIUM PRODUCTION[1]
(Thousands of pounds U_3O_8)

Operation	First Quarter 1984	Second Quarter 1984	Third Quarter 1984	Fourth Quarter 1984	Total 1984 Production
Beisa (St. Helena)[2]	338	333	107	16	794
Blyvooruitzicht	155	132	142	85	514
Buffelsfontein	313	331	337	371	1,352
Chemwes (Stilfontein)	310	279	290	276	1,155
Dreifontein Consolidated	98	104	88	61	351
ERGO[3]	113	94	71	84	362
Harmony	307	259	274	255	1,095
Hartebeestfontein	248	253	225	237	963
JMS[4]	356	265	293	402	1,316
Randfontein	287	361	361	297	1,306
Vaal Reefs	1,069	1,129	1,078	1,052	4,328
Western Areas	175	171	164	163	673
Western Deep Levels	79	82	83	78	322
TOTAL	3,848	3,793	3,513	3,377	14,531

[1] Excludes Palabora Mining Company, which is not a member of the Chamber of Mines.
[2] Mining operations ceased and underground reclamation completed.
[3] ERGO = East Rand Gold and Uranium Co. Ltd.
[4] JMS = Free State Joint Metallurgical Scheme.

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ceased uranium production on November 23, 1984. Production fell 18 percent from the 1983 figure, but the processed stockpile was sufficient to fulfill all outstanding contracts.

Buffelsfontein. No change in production in 1984 for this high-grade producer.

Chemwes (Stilfontein). Stilfontein Gold Mining Ltd. is the parent company (holding an 80-percent share) of Chemwes, which produced seven percent less U_3O_8 in 1984 due to a continued decline in yield as higher-grade slimes become depleted.

Driefontein. Production fell nine percent due to lower grade ore recovery and decreased throughput.

East Rand Gold and Uranium Co. Ltd. (ERGO). This company retreats old slimes (tailings) dams in the East Rand. A 29-percent drop in production was attributed to the continued decline in uranium grades of slimes material treated.

Harmony. Production fell 20 percent in 1984, mainly due to a plant closure. The company announced on March 12 that it had decided to discontinue production at the Merriespruit uranium recovery plant. The plant, commissioned in 1980 and one of three that Harmony operates, accounted for approximately 28 percent of Harmony's total uranium production. According to the company announcement, production from the other two plants, together with existing stockpiles, is sufficient to meet long-term committed sales. The shutdown of the Merriespruit plant will result in savings in operating costs and therefore, small improvements in profits. Harmony Chairman C. G. Knobbs cited low uranium prices as the reason for the closure, stating, "the company's role as a uranium producer was reassessed during the year in light of the depressed market conditions that are likely to prevail for some time to come."

Hartebeestfontein. Production remained constant in 1984 for this rich mine.

Free State Joint Metallurgical Scheme (JMS). Although fourth quarter production rose sharply, overall 1984 production dropped 17 percent. This decline was attributed to changes to the feed mix implemented in 1983 as well as decreased amounts of slimes and flotation concentrates treated.

Randfontein. Production increased 21 percent during 1984, largely because of expansions and modifications to the Cooke uranium plant. The plant currently is treating ore from the No. 1 and No. 2 shafts, but as treatment expands at the No. 3 shaft, it will replace ore from the low-grade No. 1 shaft. Thus, output is expected to increase further in the future.

Vaal Reefs. The Vaal Reefs/Southvaal complex (Figure 6) is the largest producer in South Africa. 1984 pro-

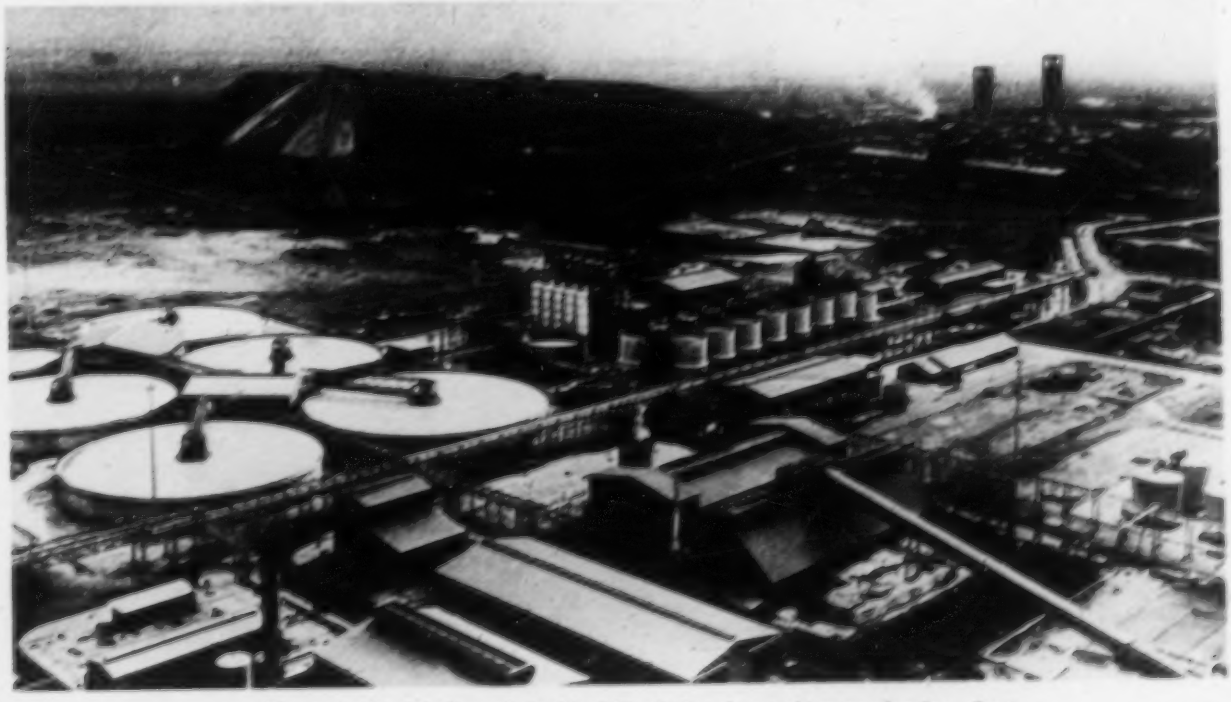

Figure 6. Aerial view of the Vaal Reefs South uranium production plant.

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duction increased five percent, which coincides with the planned level for the year. The rise is attributed to an increased contribution of tonnage from the richer south lease area.

Western Areas. Production increased eight percent in accordance with plans to expand production from the uranium-rich Middle Elsburg Reef. Although low in gold content, combined gold and uranium production from these reefs should remain profitable at gold grades exceeding 1.3 grams per ton. The company also has planned a greater utilization of plant capacity for uranium in order to meet additional contractual commitments negotiated in 1983. These commitments require additional uranium oxide production of approximately 130,000 pounds U_3O_8 in each of the next three years.

Western Deep Levels. Production fell 16 percent in 1984, as the company decided in early 1984 to cease uranium production in early 1985. The company plans to meet existing contracts from stockpiles and other arrangements. This closure will reduce South Africa's annual output by approximately 400,000 pounds U_3O_8. The board of directors of the company approved a proposal to convert a portion of the uranium plant into a gold treatment facility. The estimated escalated cost to completion is R35 million, with a target commissioning date of July 1985.

NAMIBIA

Rossing, the largest open-pit uranium mine in the world, is the sole source of uranium production in Namibia. Exact production figures have not been released, but Nuexco estimates that 1984 production declined to approximately nine million pounds U_3O_8. Nuexco's forecast indicates Rossing output will decline further in 1985, to approximately 8.5 million pounds, and remain at that level for some time. For a detailed analysis of the development, operations and geology of the Rossing project, see the two-part article in Reports 188 and 189 (April and May, 1984).

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UNITED STATES

Introduction

The US nuclear industry suffered further deterioration during 1984. Selling of excess inventories by utilities and non-producing entities continued throughout the year. Continued worldwide over-production and uncertainties surrounding the new Utility Services enrichment contract (USEC) fueled the debate over the viability of the US mining industry. Depressed U_3O_8 prices gave way to still lower US production levels for the fourth consecutive year, as several production facilities were shut down and many others reduced output. The first months of 1985 have shown no signs of market recovery.

Nuclear Power Developments

If there was a bright spot in the US nuclear industry during 1984, it was the progress utilities achieved in moving reactors toward commercial operation. During 1984, five reactors representing a total capacity of 5,258 MWe began commercial operation. Table 27 summarizes the licensing progress of US nuclear units during 1984. Four full-power licenses were issued in 1984, adding 4,534 MWe to the US nuclear generating capacity. The Nuclear Regulatory Commission granted five fuel-loading and low-power testing licenses, representing a total capacity of 5,694. Nuexco expects those five units will be licensed for full power in early 1985. Finally, one plant received a fuel-loading and cold-testing license. In addition, Diablo Canyon Unit 1, in a historic development, was restarted after meeting seismic upgrading standards. It is scheduled to begin commercial operation in mid-1985. Nuexco estimates fourteen reactors will begin commercial operation in 1985, while three more will receive full-power licenses (Table 28).

Table 27

US NUCLEAR UNITS' LICENSING PROGRESS DURING 1984

Unit	Utility	MWe Net	Type
Commercial Operation			
LaSalle 2	Commonwealth Edison	1078	BWR
McGuire 2	Duke Power Co.	1180	PWR
San Onofre 3	Southern Calif. Edison	1080	PWR
Summer	South Carolina Elec. & Gas	900	PWR
WNP 2	Washington PPSS	1100	BWR
Total		5,258	
Full-Power License			
Grand Gulf 1	Middle South Utilities	1250	BWR
Diablo Canyon 1	Pacific Gas & Electric	1084	PWR
Susquehanna 2	Pennsylvania P&L	1050	BWR
Callaway	Union Electric	1150	PWR
Total		4,534	
Fuel-Loading and Low-Power-Testing License			
Palo Verde 1	Arizona Public Service	1270	PWR
Byron 1	Commonwealth Edison	1120	PWR
Catawba 1	Duke Power Co.	1145	PWR
Waterford	Middle South Utilities	1104	PWR
Limerick 1	Philadelphia Electric	1055	BWR
Total		5,694	
Fuel-Loading and Cold-Testing License			
Shoreham[1]	Long Island Lighting	820	BWR
Total		820	

[1]License revoked by the Atomic Safety and Licensing Board in early 1985.

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NUEXCO

UNITED STATES

Construction delays and financial difficulties again were prominent in 1984 (Table 29). Eight reactors were canceled outright, representing a total generating capacity of 9,046 MWe. This figure represents 114 percent of the total capacity canceled in 1983 and 41 percent of the capacity canceled in 1982. Consumers Power Company effectively canceled its two Midland reactors, and official cancellation in the near term is probable. Finally, one reactor was indefinitely suspended.

Nuexco forecasts indicate that at least eight more reactors currently under construction or on order will be canceled. Those imminent cancellations represent approximately 9,500 MWe and approximately 3.5 million pounds U_3O_8 in unneeded average annual consumption for the units. Table 30 lists US reactor construction status in descending order of completion percentage as of December 31, 1984.

Table 28

US NUCLEAR UNITS NEARING COMPLETION IN 1985

Unit	Utility	MWe Net	Type
Expecting Commercial Operation			
Palo Verde 1	Arizona Public Service	1270	PWR
Byron 1	Commonwealth Edison	1120	PWR
Fermi 2	Detroit Edison	1100	BWR
Catawba 1	Duke Power Co.	1145	PWR
Wolf Creek	Kansas Gas & Electric	1150	PWR
Grand Gulf 1	Middle South Utilities	1250	BWR
Waterford	Middle South Utilities	1104	PWR
Limerick 1	Philadelphia Electric	1055	BWR
Diablo Canyon 1	Pacific Gas & Electric	1084	PWR
Diablo Canyon 2	Pacific Gas & Electric	1106	PWR
Susquehanna 2	Pennsylvania P&L	1050	BWR
Comanche Peak 1	Texas Utilities	1150	PWR
Watts Bar 1	Tennessee Valley Auth.	1177	PWR
Callaway 1	Union Electric	1150	PWR
Total		15,911	
Expecting Full-Power License			
Palo Verde 2	Arizona Public Service	1270	PWR
Perry 1	Cleveland Electric	1205	BWR
River Bend 1	Gulf States Utilities	940	BWR
Total		3,415	

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Table 29

US NUCLEAR UNITS CANCELED OR RESTARTED IN 1984

Unit	Utility	MWe Net	Type
Canceled			
Zimmer	Cincinnati G&E	810	BWR
River Bend 2	Gulf States Utilities	940	BWR
Marble Hill 1	Public Service Indiana	1130	PWR
Marble Hill 2	Public Service Indiana	1130	PWR
Hartsville A1	Tennessee Valley Auth.	1233	BWR
Hartsville A2	Tennessee Valley Auth.	1233	BWR
Yellow Creek 1	Tennessee Valley Auth.	1285	PWR
Yellow Creek 2	Tennessee Valley Auth.	1285	PWR
Total		9,646	
Effectively Canceled			
Midland 1	Consumers Power	530	PWR
Midland 2	Consumers Power	805	PWR
Total		1,335	
Indefinitely Suspended			
Seabrook 2	PS New Hampshire	1150	PWR
Total		1,150	
Restarted			
San Onofre 1	Southern Calif. Edison	436	PWR
Total		436	

Production

Nuexco estimates US production for 1984 at 15.6 million pounds U_3O_8, down 26 percent from 1983 production (21.2 million pounds). 1983 production fell 21 percent from the 26.8 million pounds produced in 1982. Table 31 summarizes the regional distribution of US production in 1984.

Six production facilities representing a total annual production capacity of approximately ten million pounds U_3O_8 announced plans to either cut back or shut down (Table 32). In addition, Kerr-McGee announced in January 1985 that its Quivira Mining Company will shut down indefinitely its mine and mill operations in McKinley County, New Mexico. The mill has an annual production capacity of approximately seven million pounds U_3O_8.

Most of these producers are not expected to attempt mine startups in the foreseeable future, unless an unanticipated rise in market price occurs. Non-US entities continued to penetrate the US market, gaining market share in 1984 by means of spot and long-term U_3O_8 and UF_6 sales. Unconventional and in-situ producers in the US remained active and competitive throughout the year. Solution mining in the South Texas district and phosphoric acid production in Florida and Louisiana accounted for almost 35 percent of the 1984 output. Conventional production owners continued to curtail activities during the year. Three milling operations closed down for six or more months, and several other projects were put on temporary stand-by, announcing intent to resume operations as the market recovers.

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UNITED STATES

Table 30

US NUCLEAR UNITS UNDER CONSTRUCTION AND ON ORDER

Unit	Utility	MWe (net)	Type	Percent Complete	COD[1]
Callaway 1	Union Electric	1150	PWR	100	Mar 1985
Grand Gulf 1	Middle South	1250	BWR	100	Mar 1985
Diablo Canyon 1	Pacific G&E	1084	PWR	100	May 1985
Waterford 3	Louisiana P&L	1104	PWR	100	Jun 1985
Fermi 2	Detroit Edison	1100	BWR	100	Jun 1985
Limerick 1	Philadelphia Elec	1055	BWR	100	Sep 1985
Shoreham	Long Island Lighting	820	BWR	100	Oct 1985
Palo Verde 1	Arizona PS	1270	PWR	100	late 1985
Palo Verde 2	Arizona PS	1270	PWR	99	mid-1986
Wolf Creek	Kansas G&E	1150	PWR	99	May 1985
Comanche Peak 1	Texas Utilities	1150	PWR	99	Dec 1985
Catawba 1	Duke Power	1145	PWR	99	Jun 1985
Diablo Canyon 2	Pacific G&E	1106	PWR	99	Jul 1985
Watts Bar 1	TVA	1177	PWR	99	Oct 1985
Byron 1	Commonwealth Edison	1120	PWR	97	Feb 1985
Perry 1	Cleveland Electric	1205	BWR	97	Dec 1985
Palo Verde 3	Arizona PS	1270	PWR	95	mid-1987
Hope Creek 1	Public Service E&G	1170	BWR	94	Dec 1986
River Bend 1	Gulf States Utilities	940	BWR	93	Dec 1985
Millstone 3	Northeast Utilities	1150	PWR	92	May 1986
Shearon Harris 1	Carolina P&L	900	PWR	90	Sep 1986
Clinton 1	Illinois Power	933	BWR	89	Jul 1986
Nine Mile Pt. 2	Niagara Mohawk	1080	BWR	85	Oct 1986
Catawba	Duke Power	1145	PWR	84	Jun 1987
Beaver Valley 2	Duquesne	833	PWR	83	Oct 1986
Bellefonte 1	TVA	1213	PWR	81	Apr 1989
Seabrook 1	New Hampshire Yankee	1150	PWR	80	Aug 1986
Braidwood 1	Commonwealth Edison	1120	PWR	80	Oct 1986
WNP 3	WPPSS[2]	1240	PWR	75	indefinite
Vogtle 1	Georgia Power	1100	PWR	73	Mar 1987
South Texas 1	Houston L&P	1250	PWR	72	Jun 1987
Watts Bar 2	TVA	1177	PWR	68	Apr 1988
Byron 2	Commonwealth Edison	1120	PWR	67	Oct 1986
Comanche Peak 2	Texas Utilities	1150	PWR	65	Dec 1988
WNP 1	WPPSS	1250	PWR	63	indefinite
Bellefonte 2	TVA	1213	PWR	54	Apr 1991
Braidwood 2	Commonwealth Edison	1120	PWR	54	Dec 1987
Vogtle 2	Georgia Power	1100	PWR	50	Sep 1988
Perry 2	Cleveland Electric	1205	BWR	44	indefinite
South Texas 2	Houston L&P	1250	PWR	43	Jun 1989
Grand Gulf 2	Middle South	1250	BWR	33	indefinite
Limerick 2	Philadelphia Elec	1055	BWR	31	Oct 1988
Seabrook 2	New Hampshire Yankee	1150	PWR	23	indefinite
Carroll County 1	Commonwealth Edison	1120	PWR	0	2001
Carroll County 2	Commonwealth Edison	1120	PWR	0	2002

[1]Commercial Operating Date, based on published information and utility forecasts.
[2]WPPSS = Washington Public Power Supply System.

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Table 31

1984 US URANIUM PRODUCTION BY STATE
(Millions of pounds U_3O_8)[1]

Mill Location	1984	Percent of Total 1984 Production
New Mexico	3.0	19
Wyoming	3.7	24
Texas	2.8	18
Utah	1.3	8
Others[2]	4.8	31
Total	15.6	100

[1]Nuexco estimates.
[2]Includes Arizona, Colorado, Florida, Louisiana, Nebraska and Washington.

Legislation Regarding Uranium

In January 1984, the Department of Energy (DOE) issued the new Utility Services enrichment contract (USEC) and most DOE customers converted by the October 1, 1984 deadline. The introduction of this contract has had far-reaching effects on utility demand and consumption forecasts for natural uranium.

The production sector has felt the broadening effects of the USEC as it influences utility procurement and inventory strategies for nuclear fuel. In December, three US producers filed a five-count civil action suit in the US District Court of Colorado against the DOE, DOE Secretary Donald Hodel and other DOE officials, claiming that:

1. DOE is obligated to limit enrichment of foreign uranium for domestic use so as to maintain a viable domestic uranium industry.
2. DOE unlawfully submitted the USEC and therefore it should be invalidated.
3. DOE should not be allowed to fix the transaction tails assay because it would restrict domestic uranium demand.
4. DOE should be precluded from any further sales of uranium from the government stockpile (through the split tails or pre-produced inventory policies) until a viable domestic uranium industry is assured.
5. DOE is required to adopt regulations which would restore the domestic industry's viability.

Shortly after the producers filed their suit, the Congressional General Accounting Office (GAO) issued a report which admonished DOE for violating the Administrative Procedures Act (APA) by issuing the USEC before assessing the ramifications of the contract on the mining indus-

Table 32

US URANIUM OPERATIONS SHUT DOWN OR CURTAILED IN 1984

Company	Annual Capacity[1] (Thousands of pounds U_3O_8)	Event
Atlas Corporation	2,000	Closed the Velvet, Pandora and Rim mines in February; closed the mill in March.
Tenneco	200	Suspended production at West Cole solution mine, Hebbronville, Texas.
Union Carbide Corp.	2,800	Shut down Gas Hills, Wyoming mine and mill and Uravan, Colorado mine and mill.
Western Nuclear	1,000	Closed the Sherwood, Washington mine and mill. (Plans to reopen in 1985.)
[illegible]stake Mining	3,800	Placed its Grants, New Mexico mill on standby. (Was reopened in January 1985.)
Everest Minerals	250	Shut down the Las Palmas, Texas operation.
Total	10,050	

[1]Annual capacity of the referenced operations only.

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try. It is difficult to predict the effects these accusations will have, or a possible outcome. Nevertheless, the surrounding controversy represents an attempt to force DOE to reexamine the fundamental purpose for which the USEC was created.

Outlook

Although US production has fallen at a steady rate throughout the past few years, non-US producers' capabilities at the lower price production levels continue to soar. This factor, coupled with USEC-reduced uranium consumption projections, implies the continuation of a buyer's market and depressed spot prices for the next three to five years.

Exploration and Development

Uranium exploration and mining activities decreased steadily throughout 1984 as the market for uranium concentrates continued the downward trend that began during the last quarter of 1983. Exploration and development drilling activity declined as expected based on an active rig count. Nuexco estimates total drilling at 2.0 to 2.5 million feet as compared to DOE's estimate of 3.5 million feet for 1983. (*Note:* DOE no longer collects drilling and ore reserve information related to the uranium resource industry.) Nuexco's estimate is based on information supplied by a survey of selected companies.

Exploration drilling by at least six companies in the South Texas district averaged seven working rigs per month throughout the year; development drilling averaged six rigs per month.[1] Throughout Arizona, Colorado, Nebraska, New Mexico, Utah and Wyoming, at least 13 companies participated in drilling, with an average monthly rig count of 14 for exploration drilling and seven for development drilling. In the Grants, New Mexico district, for many years the most active district in the USA, there was no exploration drilling for eight months of the year, but one to four companies drilled during August to fulfill annual property requirements; development drilling was limited to nine months with one to three rigs.

Active Projects

Exploration activity in the South Texas district continued along known geologically favorable trends located primarily in Duval, Brooks and Kleberg counties. The favored targets were fine to coarse sand and conglomerate units of the Goliad Formation. Further north in Live Oak and Bee counties, the main target remains the Oakville Sandstone. There were no significant discoveries announced in 1984; however, development drilling in certain areas proved successful in delineating additional reserves and enhancing certain active solution-mining operations.

The area north and south of Grand Canyon National Park experienced a slight surge in activity. Five or six major uranium companies continued to acquire new ground for exploration, including geophysical and drilling programs. The exploration target is potentially high-grade deposits in breccia pipe structures common to the district. In addition, another eight to ten small exploration companies and independent operators competed for the more favorable exploration targets. Constructive exploration was limited primarily to annual work requirements related to conditions of property acquisition.

Energy Fuels Ltd. (EFL) remains the most aggressive and successful operator in the district. EFL presently is mining three highly mineralized breccia pipe deposits and is developing a fourth scheduled for production sometime in late 1987 or early 1988. In addition, EFL has applied to federal and state agencies with the intent of developing yet another deposit. The proposed project site is the Canyon pipe located on the south side of the Grand Canyon. If the project proceeds, it will be the first uranium mining in the southern rim district since the Orphan pipe was last mined in 1969.

Ferret Exploration Company continued to explore its Big Red property in Dawes and Box Butte counties of Nebraska. The mineral trend at the large Crow Butte deposit has been traced for several miles south onto the Big Red property. Ferret remains optimistic about property potential as a result of the important uranium resources identified to date.

Development of the Crow Butte project (owned 50 percent by Wyoming Fuel Company and 50 percent by Ferret) has been delayed by the permitting process. The joint venture anticipates licensing and permitting requirements will be in place in early 1985 and construction of a solution-mine pilot plant should begin by mid-to-late 1985.

Everest Minerals Corp. is continuing project feasibility studies on its Highland property located in South Powder River Basin, Wyoming. Everest has announced its intent to develop a solution mine on the property, probably during the second half of 1986. The ore deposit is a down-dip westward extension of Exxon's open pit, which closed in March 1984. Events that further affected the US uranium industry in 1984 are listed chronologically in Table 6, page 20, Report 198 (February 1985).

[1] It should be noted that by Nuexco estimate, drilling time per rig varies from 5 to 25 days per month and may average less than 10 working days per rig; thus, footage drilled was held below normal capabilities.

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1985 ANNUAL REVIEW

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1985 ANNUAL REVIEW

Special Report — March 1986

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MARKET DEVELOPMENTS

NATURAL URANIUM SUPPLY, DEMAND AND PRICES

Overview

The spot market for uranium exhibited two distinctly different trends in 1985. The first half of the year witnessed the continuation of the lingering price decline that had been in effect almost continuously for the past two years. The first six Nuexco Exchange Values in 1985 were all lower than any published in the previous ten-year period, and April's value of $14.25 was the lowest since October 1974. As in recent years, this evidence of market weakness was attributable to slack demand, forced inventory liquidations, and the continued perception among both producers and consumers that large, newly discovered high-grade deposits could be brought into production as needed without a precipitous rise in prices. Beginning in July, however, the majority of bids, offers, and transactions gave persistent indications of market firming. That trend continued through the end of the year, and spot prices began a slow rise that has continued to date. This rise, only the second sustained price recovery since the all-time high of $43.40 in mid-1978 and the mid-1983 peak of $24.00, took the Exchange Value to $17.00 by the end of 1985.

Several important developments during the year influenced the mid-year turnaround.

1. A number of the highly visible distress sellers of inventory liquidated their material early in 1985, leading some market observers to conclude that the seemingly inexhaustible supply of bargain-priced material hanging over the market was in fact evaporating.

2. The US dollar weakened considerably from its record highs against a number of other currencies. As a result, many non-US buyers witnessed uranium prices falling in their own currencies during 1985, prompting many to become active in spot-market purchasing.

3. As the year progressed, a large number of utilities entered the longer-term market, soliciting proposals for some 40 million pounds of U_3O_8 equivalent for delivery in the late 1990s and 1990s. Some found that prices contained in offers for future delivery, when discounted to 1985 dollars, were still substantially higher than 1985 spot prices. Some of these utilities decided to buy uranium on the spot market and hold it in inventory until needed, effectively using spot uranium to satisfy future needs, thereby increasing near-term demand.

4. The US Department of Energy's (DOE) Utility Services enrichment contract (USEC) was declared null and void by a US District Court in September, causing widespread uncertainty regarding the future of the contract. The replacement of fixed-commitment type enrichment contracts by the requirements-type USEC had eliminated millions of pounds of artificially created demand associated with utilities' needs to fill excess DOE SWU contract commitments.

5. Secretary of Energy John Herrington declared the US uranium industry to be non-viable, leading to the increased speculation that the US government might impose limitations on the importation or enrichment of non-domestic uranium.

The First Half

The Nuexco Exchange Value declined from $15.25 in December 1984 to the ten-year low of $14.25 in April 1985 (Table 1). During early 1985, as during most of 1984, the supply of low-cost inventory continued to exceed the highly discretionary demand of a few buyers. Increased competition between sellers for the few available sales opportunities as they arose contributed to the downward pressure on prices. As had been demonstrated in previous market lows, both the volume of material purchased and the number of transactions increased dramatically in the face of extremely low prices in the first quarter of 1985. Over 20 transactions totaling almost five million pounds of uranium were reported from January through March 1985, with most buyers purchasing about one reload's requirements. This level of transaction volume continued through the second quarter of 1985 as prices remained low.

As prices fell to the $14.25 level in April, discretionary buyers became motivated to purchase from the distress sellers forcing material on the market. However, since virtually *all* demand in the market at the time was discretionary rather than fundamental, they tended to withdraw as soon as they had obtained material at bargain prices, or when any upward market trend became noticeable. Prices then stabilized at the $15.00 level for two more months. The sustained price rise hoped for by many producers did not occur because enough inventory material remained on the market at the time, and the rise from $14.25 to $15.00 drew even more material into the market.

The supply and demand figures presented in Table 2 demonstrate these trends. Uranium available for supply reached a peak of about five million pounds U_3O_8 equivalent in February. In April and May, despite the volume of material sold, uranium supply remained relatively high, slightly below three million pounds. It stayed at that level through August. Conversely, buyer demand decreased markedly in that period, from 4.1 million pounds in March to under one million pounds in May, remaining at that level until November, well after prices had firmed.

The Weakening Dollar

Throughout 1984, the US dollar had risen strongly in the international currency markets, contributing to a large trade

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Table 1

1985 NATURAL URANIUM MARKET VALUES

Determined as of the Last Day of the Month	Published in Report Number	Exchange Value[1] (per lb. U_3O_8)	UF_6 Value[2] (per kgU in UF_6)	Conversion Value[3] (per lb. U in UF_6)	Loan Rate[4] (per annum)
January	198	$15.00	—	$1.00	6%
February	199	$15.00	—	$1.00	5%
March	200	$15.00	—	$1.00	5%
April	201	$14.25	$40.50	$1.50	5%
May	202	$15.00	$42.50	$1.50	5%
June	203	$15.00	$42.50	$1.60	5%
July	204	$15.75	$44.00	$1.60	5%
August	205	$16.00	$44.50	$1.60	5%
September	206	$16.00	$44.50	$1.60	5%
October	207	$16.50	$46.00	$1.60	5%
November	208	$16.75	$46.00	$1.60	5%
December	209	$17.00	$47.00	$1.60	5%
Annual Average		$15.60	$44.17	$1.43	5.1%

[1]The *Exchange Value* is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month indicated.
[2]The *UF_6 Value* is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of natural uranium hexafluoride could be concluded as of the date indicated.
[3]The *Conversion Value* is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the last day of the month indicated.
[4]The *Loan Rate* is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month indicated.

Table 2

1985 SPOT AND NEAR-TERM[1] SUPPLY AND DEMAND FOR NATURAL URANIUM
(Active[2] inquiries as reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Uranium Supply[3] (Available for Sale)	Uranium Demand[3] (Inquiries to Purchase)	Spot and Near-Term Supply/Demand Ratio	Exchange Value (per lb. U_3O_8)
January	198	4.2	1.3	1.3	$15.00
February	199	5.3	2.3	2.3	$15.00
March	200	4.3	4.1	1.0	$15.00
April	201	2.7	1.4	2.0	$14.25
May	202	2.7	0.9	2.8	$15.00
June	203	3.5	1.3	2.7	$15.00
July	204	3.0	0.5	6.7	$15.75
August	205	3.3	1.2	2.8	$16.00
September	206	2.1	1.1	1.9	$16.00
October	207	3.2	0.9	3.6	$16.50
November	208	3.6	2.3	1.6	$16.75
December	209	3.6	2.3	1.5	$17.00
Annual Average		3.5	1.6	2.1	$15.60

[1] For delivery within one year.
[2] Involving competitive price, terms, and other conditions.
[3] Millions of pounds U_3O_8 equivalent.

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MARKET DEVELOPMENTS

imbalance in the USA. US goods on international markets were not attractive because of the strong dollar, while in the USA, non-US goods could be purchased at extremely low prices. By January 1985, the US dollar had peaked with record highs against many non-US currencies. Due to various factors, some stemming from efforts to reduce the US trade imbalance, in February 1985 the dollar began a steady decline against the Japanese yen and many European currencies. (Certain European currencies are linked by the European Monetary System (EMS[1]), so changes in the dollar value of the French franc and the West German mark, for example, have been virtually identical.) The result, illustrated in Figure 1, is that uranium prices in many consumer countries declined sharply in 1985, even when prices expressed in US dollars rose during the second half of the year. This trend improved the market for many non-US uranium buyers, but worsened the condition for European sellers. Many non-US buyers continued to purchase available material even at slightly higher dollar prices because effective prices were stable or even falling in their own currencies. Table 3 shows the change in currency per US dollar for various foreign currencies over a period from the end of 1984 to the end of 1985. Table 4 shows the change in Nuexco Exchange Value for various foreign currencies over the same period of time.

The Second Half

The second half of the year was typified by a slow firming of the market, and the Exchange Value moved from $15.00 in July to $17.00 at the end of December. Two developments at the end of September launched a period of market uncertainty that persisted throughout the remainder of 1985.

— The federal court ruling that the USEC was invalid.

— The declaration by the Secretary of Energy that the US production industry was not viable. Occurring almost simultaneously, those two events fueled speculation that:

1. Restrictions on the importation or enriching of non-US uranium would be imposed by the US government, and would thereby create a two-tiered market, i.e. one in which US-origin uranium would command a substantial premium.

2. The invalidation of the USEC would either force DOE and its customers to revert to fixed-commitment contracts, or would free DOE's customers to sign with Eurodif or Urenco, or seek secondary market sources.

The cumulative market effect of these uncertainties created upward pressure on natural uranium prices. Most sellers became confident that higher prices would prevail soon anyway, and

[1]The EMS is an agreement among several European countries, including Belgium, the Federal Republic of Germany, France, Italy, and the Netherlands, that keeps the exchange rates among the various participating currencies within a narrow trading range, except in cases of official devaluations. For example, Italy devalued the lira in the fall of 1985.

Figure 1

RATIO OF 1985 EXCHANGE VALUES TO EXCHANGE VALUE OF FEBRUARY 28, 1985 MEASURED IN SELECTED CURRENCIES.

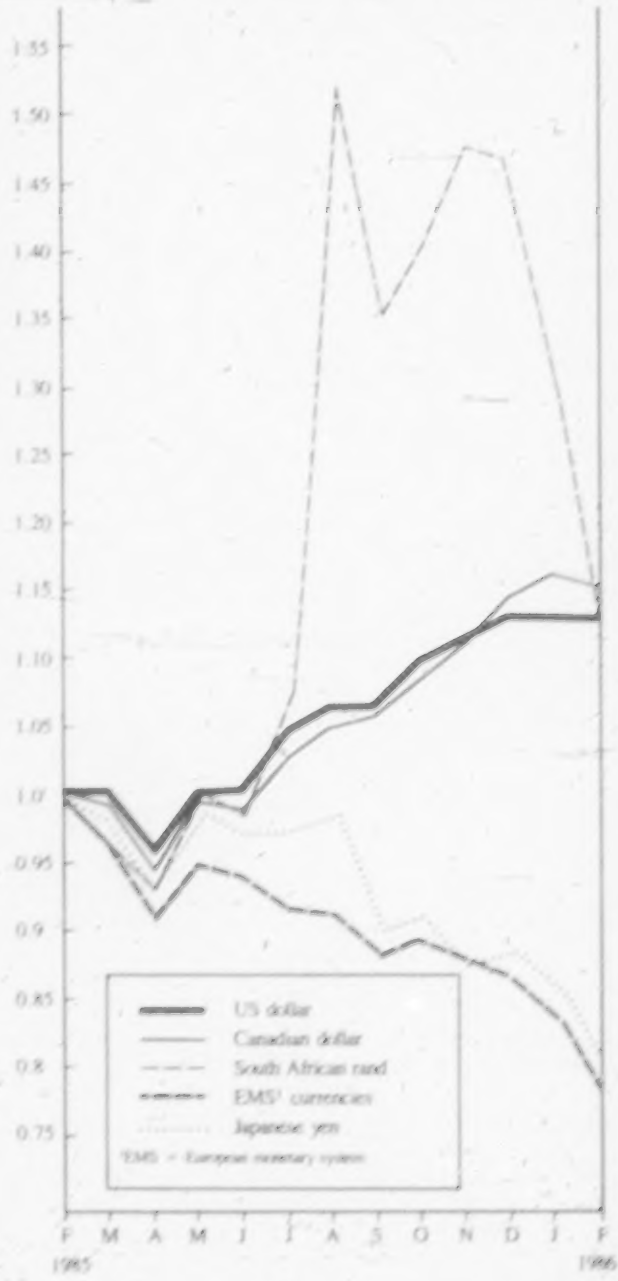

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Table 3

YEAR-END EXCHANGE RATES[1]
(Currency per US dollar)

Country (currency)	As of Dec. 28, 1984	As of Dec. 31, 1985	Percent Change
Australia (dollar)	1.20	1.47	+23
Belgium (comm. franc)	62.97	50.28	−20
Canada (dollar)	1.32	1.40	+ 6
Finland (markka)	6.52	5.42	−17
France (franc)	9.65	7.55	−22
FRG (mark)	3.15	2.46	−22
Italy (lira)	1,933	1,677	−13
Japan (yen)	250.10	200.75	−20
Netherlands (guilder)	3.55	2.77	−22
South Africa (rand)	1.97	2.58	+31
Spain (peseta)	172.95	154.20	−11
Sweden (krona)	8.96	7.59	−15
Switzerland (franc)	2.59	2.08	−20
UK (pound)	0.66	0.70	−19
US (dollar)	1.00	1.00	0

[1]Currency exchange rates from the *Wall Street Journal* of the date indicated.

Table 4

YEAR-END EXCHANGE VALUES EXPRESSED IN SELECTED PRODUCER AND CONSUMER CURRENCIES[1]

	per Pound U3O8 in Concentrates		
Country (currency)	As of Dec. 31, 1984	As of Dec. 31, 1985	Percent Change
Australia (dollar)	18.37	24.92	+36
Belgium (comm. franc)	960.33	854.70	−11
Canada (dollar)	20.13	23.78	+18
Finland (markka)	99.48	92.19	− 7
France (franc)	147.20	128.40	−13
FRG (mark)	47.99	41.87	−13
Italy (lira)	29,480	28,509	− 3
Japan (yen)	3,814	3,413	−10
Netherlands (guilder)	54.08	47.16	−13
South Africa (rand)	29.99	43.87	+46
Spain (peseta)	2,638	2,621	− 1
Sweden (krona)	136.53	128.98	− 5
Switzerland (franc)	39.54	35.31	−11
UK (pound)	13.10	11.82	−10
US (dollar)	15.25	17.00	+12

[1]Currency exchange rates from the *Wall Street Journal* of the date indicated.

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began raising their spot and near-term offering prices. Many buyers, while sharing the sense that prices could indeed move higher in the near term, nonetheless largely resisted the price rise and left the market, confirming the discretionary nature of their demand. Meanwhile, those sellers that were content to wait kept their offering prices firm, rather than actively pursuing potential buyers. The result was a sharp decline in transaction volume. In the last four months of 1985, only 2.8 million pounds were sold on the spot market.

The decision by a number of utilities to solicit long-term offers during the final months of 1985 contributed additional upward pressure on prices. Many such utilities discovered that the offers they received contained prices for further delivery that were much higher in constant dollars than present spot prices. Some buyers chose to do nothing, hoping for better offers later. But some decided to purchase additional inventory for later use, revising upward the prices they were willing to pay to procure the material on the spot market.

UF_6 Value

In May 1985, Nuexco began publishing a value for natural uranium hexafluoride. The UF_6 Value was defined as "Nuexco's judgment of the price at which transactions for significant quantities of natural uranium hexafluoride could be concluded as of the date indicated." Table 1 lists the UF_6 Value for each of the nine months in which it was published. The addition of this value was the cumulative result of many factors, including the following:

1. Over half of the natural uranium sold on the spot/near-term market in 1984 (as reported by Nuexco) involved UF_6, and nearly two-thirds of the material sold in the longer-term market in 1984 involved UF_6. In addition, transactions involving UF_6 comprised more than half of the total quantity of natural uranium sold in the first four months of 1985.

2. When the UF_6 Value was introduced in May 1985, demand for UF_6 was approximately equal to the demand for concentrates.

3. Two apparently contradictory pricing situations for conversion services had been present in the market for some time. Buyers preferring UF_6 or conversion services had been forced to pay premiums in order to do business with discretionary sellers of UF_6 or conversion services. Conversely, UF_6 sellers were forced to discount the value of the conversion component in their material in order to do business with buyers that preferred natural uranium concentrates. Therefore, at the time the value was introduced, the value of UF_6 was slightly less than the algebraic sum of the price of U_3O_8 plus the price of secondary market conversion.

The publication of a UF_6 Value presented a clearer and more complete analysis of actual market prices for nuclear fuel by eliminating misconceptions stemming from the assumption that the price of the U_3O_8 component and the conversion component would always equal the value of UF_6. In practice, the UF_6 Value rose at about the same rate as the Exchange Value during 1985. In the first few months of its publication, the UF_6 Value remained close to the algebraic sum of the Exchange Value and Conversion Value. As the supply of UF_6 increased in the second half of the year and some sellers chose to discount UF_6 in order to sell it on short notice, the value reflected the increased supply of UF_6 by dropping as much as $1.00 (per KgU in UF_6) below the algebraic sum of the Exchange and Conversion Values.

Conversion Value

In general, the conversion market stabilized in 1985, as holders of large excesses of conversion services disposed of their material and prices leveled by mid-year. Only three conversion sellers remained at the end of the year, and none of them indicated strong motivation to sell. Buyers having unfilled near-term needs for conversion services were relatively active throughout the first three quarters. Moreover, many buyers normally covered by long-term conversion contracts found that available secondary market prices for conversion could provide enough incentive to justify their cancellation of deliveries under contracts with primary converters. The conversion services then could be replaced in the secondary market. Consequently, the Conversion Value rose from $3.00 in January to $4.50 in April and reached $5.50 in June, where it remained for the rest of the year. (Table 1 lists the Conversion Values for each month of 1985, and Table 5 summarizes the supply and demand of secondary market conversion services for each month of 1985.) Active supply of conversion services rose steadily in the first half of the year, but generally declined as the price stabilized at $5.50. Demand fluctuated in the first half of the year, as discretionary buyers entered and exited the market, but in later months, demand was virtually nonexistent.

Loan Rate

In March, the Loan Rate declined from six percent to five percent per annum, as a potential lender began offering a substantial quantity of material at that rate. Thereafter, the Loan Rate did not change. The loan market remained quite dormant throughout the year, as in 1984. Nuexco was aware of only a few prospective borrowers during the entire year. Several potential lenders continued to offer substantial supplies of material (each on the order of two million pounds) for loan. In the past few years, however, low uranium prices in the spot and near-term markets have made purchasing more attractive than borrowing, the need for payback and credit arrangements has largely discouraged many potential borrowers from entering loan agreements. Table 5 lists the supply and demand for natural uranium loans in 1985.

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Table 5

1985 SUPPLY AND DEMAND FOR SECONDARY MARKET CONVERSION[1] AND NATURAL URANIUM LOANS[2]
(Active[3] inquiries as reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Conversion Supply (Thousands of pounds U as UF_6)	Conversion Demand	Loan Supply (Thousands of pounds U_3O_8 equivalent)	Loan Demand	Exchange Value
January	198	0	390	0	0	$13.00
February	199	300	255	0	0	$15.00
March	200	110	255	0	0	$25.00
April	201	550	290	0	250	$14.25
May	202	1,600	965	0	300	$15.00
June	203	1,660	965	0	300	$25.00
July	204	360	425	0	300	$25.75
August	205	325	525	2,300	500	$16.00
September	206	100	0	2,000	500	$16.00
October	207	0	0	2,000	0	[illegible]
November	208	0	0	2,000	0	$16.75
December	209	300	0	2,000	0	$17.00

[illegible] delivery within three years.
[2]Data refer to spot and near-term demand, i.e. material to be delivered in the maximum within one year.
[3]Involving competitive price, terms, and other conditions.

Analysis of Uranium Sales Transactions

During 1985 Nuexco reported 70 transactions involving the spot or near-term sale of approximately 15.5 million pounds equivalent U_3O_8. This quantity was divided between U_3O_8, natural UF_6, and low-enriched uranium. Table 6 shows a breakdown of 1985 spot or near-term uranium sales transactions listed in the Nuexco Monthly Report.

As in past years, Nuexco's reporting of nuclear fuel transactions is subject to some limitations. Certain transactions may not have been reported because of one or more of the following circumstances.

1. Nuexco chooses not to report transactions (or certain information about published transactions) if the reporting of such information would jeopardize client confidentiality.

2. Transactions of which Nuexco was not aware, or those about which sufficient reliable information could be ascertained, are not reported.

3. Because of the subjective nature of Nuexco's judgments, some agreements between parties may be reported as transactions only to collapse later during final negotiations. An agreement may be judged a transaction as soon as the parties verbally agree, as late as contract signing, or even later, depending on Nuexco's confidence that the agreement will be concluded. In addition, different market observers, even if given identical information, can reach different conclusions on the question of when a negotiation becomes a transaction that merits reporting.

Table 6

TRANSACTIONS: SPOT OR NEAR-TERM URANIUM SALES[1] REPORTED BY NUEXCO IN 1985
(Thousands of pounds U_3O_8 equivalent)

SELLERS	BUYERS		
	Utilities	Producers	Others
Utilities	3,500	0	1,050
Producers	4,675	1,725	1,640
Others	2,255	340	300

[illegible] not include transactions which fall into one or more of the following categories:

a. Transactions which took place in 1984 but were reported in 1985.
b. Transactions which involved spot lots and fuel.
c. Transactions of which Nuexco was not aware.
d. Transactions that Nuexco was aware of but chose not to report, either to protect client confidentiality or because Nuexco was not satisfied with the reliability of the information, and/or
e. A negotiation which has not advanced to such a degree that Nuexco would judge it a completed transaction. Because of the subjective nature of Nuexco's judgments, some pending negotiations are later [illegible] reported as transactions only to fall through later. In these cases, the transaction was omitted from this table.

[1]Finally, a transaction is not a delivery of material, and options or non-deliveries from old transactions are not regarded as transactions.

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4. Delivery of material under old contracts, new deliveries or the exercise of options for additional material under old contracts are not regarded as new transactions. Similarly, renegotiations of old contracts are not included as new transactions.

5. The analysis of 1985 transactions did not include those which took place in 1984 but were reported in early 1985, as well as transactions involving material other than U3O8 concentrates, natural UF6, or low-enriched uranium.

Of the 70 uranium sales transactions reported in 1985, 46 involved U3O8, 21 involved natural UF6, and three involved low-enriched uranium. In terms of the pounds of material delivered (or to be delivered), approximately 42.4 million pounds (87 percent) consisted of concentrates, and 4.9 million pounds U3O8 equivalent (13 percent) consisted of natural UF6. The foregoing amounts incorporate some data refinements made since the transactions were first published.

The overwhelming majority of buyers in 1985 transactions were utilities, both in terms of the number of transactions and the volume of material. Utilities contracted for two-thirds of the material sold in 1985. The sellers, however, were rather evenly distributed between producers, utilities, and others, including trading companies, fabricators and government entities. Of the material purchased by utilities in 1985, about 45 percent came from producers, 35 percent from other utilities, and about 20 percent from other sellers. Inventory liquidation and redistribution by utilities — one of the more significant downward pressures on the Exchange Value in 1985 — resulted in a total of 3.5 million pounds of uranium changing hands between utilities, and another one million pounds diverted by utilities (often only temporarily) to other buyers. That 4.5 million pounds of uranium removed [illegible] from utility inventories was almost twice the amount liquidated in 1984.

As in the past several years, producers found that sometimes it is more economical to purchase on the spot market to meet delivery requirements than to continue high-cost production operations. Thus, producers bought over 2 million pounds of uranium on the spot market in 1985 (about 13 percent of the total), more than doubling the previous year's level of producer buying.

Other entities, mainly trading companies, purchased equally from both producers and utilities, and in turn sold a total of approximately 2.3 million pounds U3O8 equivalent, primarily to utilities. This amount was significantly less than the 3.4 million pounds sold by other entities to utilities in 1984.

The majority of the uranium liquidated by utilities in 1985, regardless of its destination, took the form of UF6. One utility sold a large quantity of U3O8, and two sold enriched UF6. Approximately half of the uranium sold by other sellers consisted of UF6. Although there were 29 sales from producers to utilities, only four of the transactions involved UF6; nevertheless, by weight the UF6 accounted for more than one-quarter of the material sold between these groups.

Transaction Value

Table 7 lists the Transaction Value and its associated parameters for each month of 1985. The Transaction Value is a weighted average of prices paid for natural uranium in spot or near-term transactions of immediately preceding months. The conditions for the calculation stipulate that at least ten transactions, totaling at least 2 million pounds U3O8 equivalent, must be included in each calculation, and that the sample time must be extended as necessary to include these minima. Thus, transactions included in the Transaction Value generally are a subset of those that are listed under the category "Uranium Sales" in the *Current Market Data* section of each Report. Because of the inclusion of transactions from at least the previous two months, the Transaction Value historically trails the Exchange Value when it is moving up or down.

The Transaction Value fell steadily for the first five months of 1985, reacting to the falling prices paid in transactions in those months. The Exchange Value low of $14.25 at the end of April reflected a large producer's liquidation in an already weak market, and the Transaction Value continued to drop, reaching its lowest level ever at the end of May ($14.45). As transactions involving higher prices began to replace those involving prices below the $15.00 level, the Transaction Value rose steadily for the remainder of 1985, trailing the Exchange Value by a range of about $0.50 to $1.00.

Fifty-four 1985 transactions were used in the Transaction Value calculations, and their total quantity was 10.4 million pounds equivalent U3O8. The weighted average price in these transactions was $15.19, approximately $0.40 below the *unweighted* average of 1985 Exchange Values.

Loans and Secondary Market Conversion Transactions

Table 8 lists the single loan transaction and the eight secondary market conversion transactions that were reported in 1985. The overall weakness in the uranium market has contributed to a nearly dormant market for uranium loans over the past several years, a degree of inactivity reflected both in the supply and demand figures and in the general absence of loan transactions.

Discretionary conversion buyers (almost exclusively utilities) occasionally entered the secondary market to engage in transactions, but usually not at what would be termed "bargain" prices. Most of the transactions occurred at or near the prevailing Conversion Value, indicating that sellers of conversion services were not motivated to reduce prices merely to liquidate excess conversion, a situation that continues to characterize the secondary conversion market today.

Table 7

1985 TRANSACTION VALUES[1]
(and associated parameters)

Calculated as of the Last Day of the Month	Report Number	Transaction Value (per Bt. U.Gr.)	Millions of Pounds	Number of Transactions	Number of Months
January	198	$16.20	2.1	14	4
February	199	$15.79	2.3	13	4
March	200	$15.05	2.4	16	3
April	201	$14.90	2.9	20	3
May	202	$14.45	4.6	20	3
June	203	$14.80	4.5	17	3
July	204	$14.94	4.0	17	3
August	205	$15.10	2.4	14	3
September	206	$15.10	2.7	17	4
October	207	$15.75	2.2	13	4
November	208	$15.80	2.9	14	5
December	209	$16.55	2.1	11	3
Annual Average		$15.20[2]	3.0	16	4

[1] The Transaction Value is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
b. At least ten transactions;
c. Transactions involving a sum total of at least 2 million pounds U.Gr.equivalent.
The sample size is extended as necessary to include these minima. Other commissars are converted to US dollars using commission rates in effect on or near the transaction date.
[2] This average is a weighted average.

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Table 8

1985 URANIUM LOANS AND SECONDARY MARKET CONVERSION TRANSACTIONS REPORTED BY NUEXCO

Loan Transactions

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds U3O8 equivalent)	Approximate Price as Percent of Current Loan Rate	Lender	Borrower	Remarks
3451	1985	101-300	100	European Entity	Trader	

Conversion Services
Secondary Market Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds U equivalent)	Approximate Price as Percent of Current U3O8	Seller	Buyer	Remarks
3268	1985	301-600	100	U.S. Utility	European Utility	
3340	1985	50-100	93	U.S. Utility	U.S. Utility	
3332	1985	101-300	100	U.S. Utility	Trader	
3357	1985	101-300	95	W	U.S. Utility	
3429	1987-88	301-600	Undetermined	Fabricator	European Utility	Price escalated from contract signing
3443	1985	301-600	100	Trader	U.S. Utility	
3547	1985	less than 50	90	U.S. Utility	U.S. Utility	
3572	1986	101-300	94	U.S. Utility	U.S. Utility	

W The notation W means that Nuexco either does not know, or that Nuexco has instructed the information to protect client confidentiality.

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SECONDARY MARKET ENRICHMENT SERVICES

Introduction

The secondary market for enrichment services underwent a period of substantial change in 1985. The controversial court decision nullifying the Utility Services enrichment contract (USEC), combined with several broad pronouncements by DOE regarding its market strategy, created worldwide uncertainty over the future of DOE's significant share of the enrichment market. These factors were to dictate the nature of secondary SWU market activity in 1985:

1. In an effort to compete directly with non-DOE SWU suppliers for that portion of its customers' requirements in excess of 70 percent under the USEC, DOE proposed an incentive pricing program for fiscal years 1987 through 1990.

2. DOE announced a series of concrete measures designed to bolster its customers' confidence in DOE's present and future performance and pricing schemes. These measures included a USEC base price reduction to $125 per SWU, a commitment to AVLIS deployment, and the cancellation of the gas centrifuge enrichment plant (GCEP) program.

3. A U.S. District Court ruled that because some of the USEC terms and conditions amounted to changes in the criteria governing enrichment services and the required Congressional approval was not obtained, the contract was null and void.

4. Despite the possible consequences of an invalidated USEC, DOE rapidly sought to increase its market share by inducing more customers to commit to take 100 percent of their enrichment requirements from DOE well into the 1990s. DOE offered a second incentive pricing campaign to its customers, covering FY87-97.

Secondary market activity fluctuated in response to these announcements and uncertainties, but innovative and competitive marketing on the part of the primary enrichers left fewer uncommitments open to secondary market SWU's in 1985. This trend probably will continue as more utilities commit their requirements into the 1990s to the primary suppliers, which will probably continue to lower their prices for enrichment services.

Price Movements

Table 9 presents the various Nuexco SWU Values that were in effect throughout 1985. The Value for DOE-SWU's certifiable in excess generally decreased throughout the year. The Value for FY85 delivery began the year at $112 per SWU and decreased rapidly to $98 per SWU by the third month. This decline was due almost exclusively to vigorous reductions by the few remaining sellers to a fundamental lack of demand. By the end of March, DOE's requirement that it be given 180-day notice of the quantity and assays of the enriched product had expired. Thus, the FY85 market had virtually vanished and buyers began to focus on the FY86 market. (After the 180-day notice expires, it is still possible to conclude transactions for delivery in that fiscal year. Customers could perform a swap involving the exact enrichment percentage that was needed, or could possibly persuade DOE to waive its 180-day notice requirement.)

In late 1984 and early 1985, the Value for DOE SWU's certifiable in excess for FY86 delivery had been expressed in terms of a discount from the FY86 USEC price because the FY86 price had not yet been announced and the preponderance of offers in that period were discount-priced rather than fixed-priced. In April, as the market began acknowledging that the FY86 base price would probably become $125 (which occurred several months before DOE's announcement to that effect), Nuexco began publishing the value as a fixed price rather than a discount.

Most of the market anticipated a lower DOE SWU price for FY86. Furthermore, the favorable response to DOE's incentive price offer for FY87-90 SWU's effectively made FY86 the last year of demand for certifiable SWU. These factors maintained downward pressure on the DOE certifiable price, which fell from $110 per SWU (based on the $125 price and a $15 discount) in January to $78 in November.

Nuexco published two prices for SWU's of "other" origin, i.e. non-certifiable or non-DOE origin SWU, for calendar years 1985 and 1986. The 1985 value for other SWU's was in effect throughout the first six months of 1985, although that market was largely dormant. The little activity that did occur centered around the European primary enrichers Eurodif and Urenco, as they formulated their market strategy in response to the success of DOE's incentive price offer for FY87-90. By June, no demand surfaced and it was evident that the DOE and non-DOE markets had converged. The 1986 value behaved in very much the same way as the DOE-certifiable value. It began the year at $90 per SWU, dropping to $78 at the end of September. Most of the demand had been filled until 1987, and DOE's incentive price offer helped soften the market for calendar year 1986. In addition, as the U.S. dollar weakened during the second half of the year, spot-market sales became less attractive to non-U.S. sellers, primarily the secondary market sellers.

Nuexco began publishing prices reflective of a two-tiered secondary market for enrichment services in November 1983, when, as a result of the modified Interim Sales Contract, it became apparent that the DOE-origin and non-DOE-origin SWU markets were characterized by very different prices. Subsequently, the two-tiered pricing structure changed somewhat, reflecting the importance of certifiability of DOE-origin SWU.

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In the second half of 1985, largely because of the existence of DOE's two incentive pricing initiatives, the two markets began to converge until there was no difference in the prices obtained in either market. Thus, in December 1985, Nuexco returned to a single SWU value.

The DOE Enrichment Program

The dynamics of the enrichment market in 1985 were driven by DOE's two incentive price initiatives and the invalidation of the USEC by a federal court. In addition, DOE released a long-term strategy based on a renewed sensitivity to market forces.

The FY87-90 Incentive Pricing Program. In early April, DOE submitted its first incentive pricing proposal in an attempt to capture the uncommitted portion of its customers' SWU requirements in the FY87-90 period. It included the following conditions:

1. The FY87 and FY88 price was set at $90 per SWU. For FY89 and FY90, the $90 price is to be escalated from October 1, 1988 according to the escalation formula set forth in the USEC.

2. The customer had to commit to buy 100 percent of formerly *uncommitted* requirements under the program.

3. The customer could purchase more than 30 percent of requirements under the program, thereby reducing the nominal USEC percentage below 70 percent—if a termination given before December 31, 1985 had created such an opportunity.

4. The customer could purchase less than 30 percent of requirements under the incentive pricing program, to the extent necessary to accommodate a contract agreed to before February 15, 1985.

5. The customer could select any tails away between 0.2 weight-percent (w/o) and 0.3 w/o at no charge, but only one tails away could be selected per order. This last provision was known as the "free VTAO (Variable Tails Away Option)."

The response to the first offer was overwhelmingly positive; the only exception was the European market where DOE's market share continues to shrink. Thus, DOE had succeeded in capturing most of the uncommitted SWU market for the four-year period, and almost all of that market outside Europe.

September Events

Several important events occurred in September 1985. DOE announced its FY86 SWU prices, including the first announcement of a high-assay charge for enrichment over 10 w/o. It also disclosed its long-term enrichment strategy. Shortly thereafter, a U.S. District Court in Denver ruled that the USEC was null and void. The ruling was a response to one count of a five-count law-suit brought against DOE by a group of U.S. uranium producers. One week later, U.S. Secretary of Energy Herrington declared that the U.S. uranium industry was no longer viable.

Table 9

1985 SWU VALUES

Determined as of the Last Day of the Month	Published in Report Number	DOE-certifiable origin		Non-DOE or non-certifiable origin	
		FY85 Delivery	FY86 Delivery	1985 Delivery	1986 Delivery
January	199	$112	$151	$80	$90
February	199	$102	$250	$80	$88
March	200	$ 98	$250	$80	$85
April	201	—	$95	$80	$85
May	202	—	$90	$80	$85
June	203	—	$90	—	$83
July	204	—	$85	—	$81
August	205	—	$85	—	$81
September	206	—	$85	—	$79
October	207	—	$83	—	$83
November	208	—	$78	—	$78
December	209	—	—	$80[1]	—	—

[1] Represents a discount from USEC base price on delivery.

[2] The SWU Values were changed in Report 208 to one value representing any origin of SWU for delivery within one year.

FY96 DOE SWU Prices. On September 4, DOE announced that the FY96 base price for enrichment services under the USEC would be reduced $30, to $125 per SWU. In addition, DOE set a high-assay charge of $492 per SWU for separative work performed in excess of 77 w/o, effective April 1, 1996. Because of the ceiling price in the USEC, commercial power customers were only marginally affected by the high-assay charge, which has a greater effect on customers such as the Department of Defense.

DOE's Long-Term Strategy. At a meeting with non-US utilities, DOE made its long-term enrichment strategy public, which included the following issues. Some of the announcements had been made in June, but were now combined as part of an overall strategy.

1. In announcing the reduction of the USEC base price to $125, DOE stated that the price might be lowered further to $115, competitive with European enrichers, within four years. DOE also implied that the price might be reduced in the 1990s to a level unrivaled by competitors, culminating in a $90 per SWU price in 2000.

2. DOE predicted that a $250 million cost reduction will be accomplished from 1996 to 1999 at the two operating gaseous diffusion plants at Paducah, Kentucky and Portsmouth, Ohio. DOE plans to improve the economic efficiency of the plants by utilizing off-peak electricity for 50 percent of the off-peak power demand. Finally, DOE announced that the Oak Ridge, Tennessee plant will be placed on standby as a cost-cutting measure, and would resume production if the demand exceeds 14,000 metric tons enriched UF6.

3. DOE decided to proceed with the development of Atomic Vapor Laser Isotope Separation (AVLIS) as the future US enrichment technology. The stated rationale for the decision included the following projections, none of which has been demonstrated to date:

   a. The *potential* for reductions in production costs is high.

   b. The amount of investment required for AVLIS, supposedly no more than $3 billion, may be only half as much as that required to fund an advanced gas centrifuge plant.

   c. A small-scale AVLIS plant should be able to operate as efficiently as a large-scale plant.

Invalidation of the USEC. Judge Carrigan's ruling, first announced September 16 and amended September 19, addressed Count II of a five-count civil suit filed against DOE in December by three US uranium producers — Western Nuclear Inc., Energy Fuels Nuclear Inc., and Uranium Resources Inc. The action had the support of other US producers, many later formed an industry trade group called the Uranium Producers of America (UPA). That body has since assumed the leadership of the group's legal efforts. In Count II, the suit sought a declaration that the USEC is null and void and an order prohibiting DOE from adopting a generic enrichment contract without compliance with the Administrative Procedure Act. (Reports 197 and 206 contain analyses of the events leading up to the filing of the suit and the District Court ruling in September.)

Under the Atomic Energy Act, DOE is required to establish written criteria describing terms and conditions for enrichment services. Furthermore, the adoption of any new criteria requires submission of the contract to Congress for review. In his order, Judge Carrigan stated that the critical issue regarding the USEC was that it "... (amounted) to new criteria governing enrichment." He cited three examples:

1. Existing criteria governing enrichment require that the primary DOE enrichment contract must be of a fixed-commitment type, which the USEC clearly is not.

2. The USEC sets a ceiling price for enrichment services, which conceivably could prevent the government from recovering its costs. In 1971, for the same reasons, a similar provision which guaranteed a ceiling price was deleted from original criteria established in 1966.

3. Provisions in the USEC that base termination penalties on the period of notice that the customer gives DOE, rather than on recovery costs derived from DOE estimates of customer terminations, should be considered new criteria.

Thus, Judge Carrigan declared the contract null and void, and entered a summary judgment in favor of the producer group and against DOE with respect to Count II of the suit. DOE soon afterward filed a notice of its intent to appeal the ruling, a measure which extended to 60 days the period allowed for filing an appeal. In December, DOE and the producer group attempted to settle the matter out of court but failed to reach a resolution. In January 1996, DOE formally proposed new criteria to govern its uranium enrichment contracts. Apparently concluding that the most favorable resolution consisted of changing the criteria, DOE drafted extensive revisions to the existing criteria, and will submit the revisions for a 45-day Congressional review once the final wording is established. The proposed criteria will become effective if during that time Congress does not object. If the changes are accepted, they will be applied retroactively to the USEC, at which point a number of new legal complications are certain to arise. Report 211 (March 1996) examines some of the implications of the revised criteria.

The FY91-95 Incentive Pricing Program

At the end of 1995, DOE initiated a second incentive price program. This offer to USEC customers covered unfilled requirements from FY91 through FY95. As with the first offer, DOE attempted to capture the "30-percent" market created by the USEC. The base price per SWU under the new offer is the

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lower of the USEC price in effect at time of delivery or $45 escalated using the GNP Implicit Price Deflator for the second quarter of 1985. Again, in order to receive this price, the customer must agree to purchase all uncommitted requirements from DOE during the period. Responses were due on February 21, 1986.

Ultimately, the overall reaction did not approach the success of the first offer. It appeared that some utilities chose to negotiate their acceptances to the proposal, attaching conditions such that the acceptances might more properly be described as counter-proposals. The lack of enthusiasm for the second proposal probably stemmed from the uncertainty surrounding the USEC. Some utilities were undoubtedly reluctant to place even greater reliance on a supplier that may not be able to deliver services under an invalidated contract. Similarly, some utilities may have determined that committing 100 percent of requirements to DOE as much as ten years in the future may leave them vulnerable to governmental mandates that affect DOE, such as cost recovery and investment payback, which might be passed on to customers in the form of uncompetitive pricing terms, delivery schedules, or termination charges. Finally, the economic gains contained in the offer may not have been attractive enough for some customers.

Concurrently, DOE agreed to waive the variable tails assay option fee for any year in which a USEC customer commits to take 100 percent of its requirements from DOE. This offer commences in FY87 and has no termination date. DOE indicated that the offer was based on the Secretary of Energy's finding that the U.S. uranium industry was non-viable, and was intended to help rectify this situation by increasing the use of natural uranium.

1985 Secondary Market Enrichment Transactions

Table 10 lists data regarding secondary market SWU transactions reported by Nuexco in 1985. A total of approximately 1.4 million SWUs were sold in 19 transactions. About 60 percent of the total number of SWUs sold were of Eurodif origin, and the remaining 40 percent were of DOE origin. About ten percent of the SWU purchased was contained in enriched uranium.

In general, buyers can be divided into two categories. Smaller quantities of SWU were bought by USEC holders that were able to use DOE-certifiable SWU to fill part of their requirements. Larger quantities were purchased by DOE customers that had terminated requirements contracts. Sellers included Eurodif shareholders having excess commitments, utilities that had cancelled nuclear power plants, and former DOE Adjustable Fixed-Commitment contract holders that had excess deliveries.

Table 10

SECONDARY MARKET SWU TRANSACTIONS[1] REPORTED BY NUEXCO IN 1985

Delivery Period	Number of Transactions	Thousands of SWUs	DOE-origin (percent)	Eurodif-origin (percent)
1985	7	185	100	0
1986[2]	11	1,170	30	70
Total	18	1,355	40	60

[1] Data includes transactions which occurred in 1985. Does not include transactions for which Nuexco has incomplete or unreliable data. Some transactions may have been updated after original publication.
[2] Includes one transaction having deliveries beyond 1986.

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WORLD URANIUM PRODUCTION

World uranium production in 1985 totaled 89.6 million pounds U_3O_8, a ten-percent decline from the 1984 level. This figure represents a 22-percent decline from the record level of 115 million pounds produced in 1980. Substantial declines in production in the USA, Australia and South Africa account for most of the change from 1984 to 1985. This was especially evident in the USA, where conventional operations produced only 5.4 million pounds U_3O_8, the lowest figure since 1953. Overall production in the USA fell 26 percent in 1985. Table II presents a comparison of Nuexco production estimates for 1984 and 1985.

Australia's production fell 17 percent, from 10.3 million pounds U_3O_8 in 1984 to 8.5 million pounds in 1985. The decrease is largely attributed to lower output from Energy Resources of Australia's (ERA) Ranger operation, which produced 5.6 million pounds, 1.9 million pounds less than 1984. Production at Queensland Mines' Nabarlek project increased slightly in 1985.

Canadian production fell two percent in 1985, as both Denison Mines and Rio Algom reported small declines at their Ontario operations. Eldorado Resources also reported reduced output at its Rabbit Lake mill in Saskatchewan, as mining at the Rabbit Lake mine ceased in 1985. The mill has begun processing ore from the Collins Bay "B" deposit. Also in Saskatchewan, Cluff Lake production increased 30 percent and Key Lake production increased slightly, maintaining its capacity of about one million pounds per month. For the second consecutive year, Canada produced more uranium than any other country in the world, and will continue to do so for the foreseeable future.

The suspension of by-product uranium mining at Bilyvoornutracht and the closure of the Beisa (St. Helena) mine contributed to a 15-percent decline in production in the Republic of South Africa. Western Deep Levels also suspended operations in the second quarter of the year. In addition, output fell more than 50 percent at the Chemwes and ERGO (East Rand Gold and Uranium Company Ltd.) operations. Several other Chamber of Mines producers recorded small increases, and Palabora's output increased to 478,000 pounds U_3O_8 in 1985. The weakness of the rand has had a major influence on the continuation of uranium operations in South Africa, as producers received mixed profits in 1985.

US production totaled 11.1 million pounds U_3O_8 in 1985, a 26-percent decline from the Energy Information Administration's (EIA) 1984 figure of 14.9 million pounds. Conventional production accounted for slightly less than 50 percent of the 1985 level, by-product operations and *in situ* operations accounted for 32 percent and 19 percent of US production, respectively. Two phosphate-recovery producers, IMC (International Minerals & Chemical Corp.) and Freeport Uranium, led US production.

Table 12 lists Nuexco's estimates of historical world uranium production for 1980 through 1985. While estimates made at the end of each year are reasonably accurate, Nuexco regularly updates this information based on official production results and other new information. We welcome any additional refinements to our data.

Table II

WORLD URANIUM PRODUCTION IN 1984 AND 1985
(Millions of Pounds U_3O_8)

Country	1984	1985	Percent Change
Australia	10.3	8.5	−17
Canada	29.0	28.5	−2
France	8.2	8.0	−2
Gabon	2.3	2.3	0
Namibia	9.6	9.0	−6
Niger	8.5	8.3	−2
South Africa	14.9	12.7	−15
United States	14.9	11.1	−26
Other[1]	1.7	1.4	−18
WORLD TOTAL	99.4	89.6	−10

[1] Includes Argentina, Belgium, Brazil, Portugal, and Spain.

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MARKET DEVELOPMENTS

Table 12

HISTORICAL WORLD[1] URANIUM PRODUCTION[2], 1980-1985
(Millions of pounds U_3O_8)

Country	1980	1981	1982	1983	1984	1985
Australia	4.1	8.1	11.6	8.4	10.3	8.5
Canada	18.6	20.1	21.0	18.6	29.0	28.3
France	6.8	6.6	7.8	8.5	8.2	8.0
Gabon	2.7	2.7	2.5	2.6	2.3	2.3
Namibia	10.5	10.3	9.8	9.7	9.6	9.0
Niger	10.7	11.3	11.3	8.9	8.5	8.3
South Africa	16.0	15.9	15.1	15.8	14.9	12.7
United States	43.7	38.7	28.8	21.2	14.9	11.1
Other[3]	1.8	1.1	1.9	1.7	1.7	1.4
WORLD TOTAL	114.9	114.8	107.7	95.3	99.4	89.6
(rounded)	115	115	108	95	99	90

[1]Outside Soviet bloc areas.
[2]Figures presented are Nuexco's best estimates.
[3]Includes Argentina, Belgium, Brazil, Portugal, and Spain.

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AUSTRALIA

Political Developments

In political terms, the Australian uranium industry experienced a period of stability during 1995. In keeping with the policy established by the Labor government, uranium mining was limited to the two existing producers, Energy Resources of Australia (ERA) and Queensland Mines. Future developments were limited to one additional mine, Olympic Dam (Roxby Downs). This policy was the best compromise the Australian Labor Party could produce within its diverse constituency, and for the most part, uranium mining has now ceased being a serious public issue in Australia.

Against this background, the most significant market development involved the apparent reinterpretation of the government's floor price policy. The Australian government maintains an export approval system for nuclear materials. Since 1979, this approval system has included the requirement that all sales must adhere to a floor price of about US$30 per pound U3O8. While exports under existing long-term contracts continue to be priced at or above that level, such price rigidity has proved a serious impediment to obtaining new, firm sales contracts and has effectively barred market entry to the Olympic Dam project, while Canadian, African and even some US sellers could offer extensive flexibility in pricing and other contract terms. Olympic Dam, with its considerable economic and political implications for the state of South Australia, needed price relief, without which it could not proceed.

Though the Australian government has remained officially silent on this matter, it became apparent during the last half of 1995 that some revision or reinterpretation of the floor price policy, in order to relate to market realities, was either imminent or already agreed upon. While several possible approaches have been discussed, the precise nature and means of implementation of such a policy revision remain unknown. In view of the past emphasis on the US$30 price, it does seem likely that the government will continue some token observance of that price level in order to counter the likely criticisms that the country's resources were being sold too cheaply.

International Affairs

Consistent with its nonproliferation policy, Australia negotiated a bilateral safeguards agreement with Switzerland during 1995, which was signed in January 1996. The agreement must be ratified by the Swiss Parliament and federal government. Safeguards policy negotiations with Egypt have made little progress over the last five years. Although Egypt has been seeking such a treaty, Australian officials are hesitant due to the possibility of domestic opposition.

The Australian government is still considering its response to proposals from Euratom to permit origin swaps or book transfers of Australian-origin uranium. Such an origin-swap policy, a recurring item on the agenda in discussions with Euratom, is scheduled to be formulated in 1996.

Production Results

Total 1995 production amounted to 8.5 million pounds U3O8, a 17 percent decline from 1994 production. The total represents approximately 9 percent of 1995 WOCA production. In general, despite continuing market weakness, Australian uranium companies prepared for 20 million "Sonic" specific comments on production operations.

Ranger — ERA maintained its marketing drive in the USA and in Korea, concluding agreements for deliveries beginning in the late 1990s. In calendar year 1995, the Ranger mine produced 5.5 million pounds, some 1.1 million pounds below rated capacity. This shortfall was attributed to maintenance and tests conducted during the third quarter in order to determine the maximum capacity of the existing plant. The company has indicated that production increases in the first half of 1996 will offset shortfalls from the second half of 1995, so that ERA will meet its production target of 6.6 million pounds U3O8 for the fiscal year ending June 30, 1996. The company also announced its intention to double its annual production in two stages, from the current level of 6.6 million pounds U3O8 to 9.9 million pounds by 1998, and to 13.2 million pounds by 1999.

Ranger's water management problems remain unresolved. Because the mine is surrounded by the Kakadu National Park, specific environmental controls were attached to the mining lease. Under its operating permit, Ranger may not release water into the environment except by evaporation, which has proved inadequate. Thus far its twin pit system has helped to store excess water, but in two years only a single pit will operate. Then all excess water must be removed if operations are not to be disrupted.

Some sources believe that only an early release of a substantial quantity of water will allow Ranger to ease the burden on its water management system, which is approaching capacity levels. However, repeated discharge of water from the Ranger catchment into the Magela River system is environmentally and politically unpopular, and Aboriginal groups and Wildlife Services are opposed to any release of water.

Nabarlek — Queensland Mines, Ltd. continued to mill stockpiled uranium ore at its Nabarlek operation. Production in 1995 amounted to 2.9 million pounds U3O8. As a consequence of its decision to ban uranium shipments to France, the federal

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AUSTRALIA

government continued to purchase the uranium that Queensland Mines had agreed to sell to the French state utility Electricite de France. The ban, enacted as a political protest to French nuclear weapons testing in the South Pacific, was officially declared in early 1983, but was not actually enforced until Queensland was denied an export license for a delivery in late 1984.

Faced with the exhaustion in the late 1990s of its Nabarlek ore stockpile, Queensland Mines is negotiating with Aboriginal Northern Land Council in order to secure rights to reactivate its exploration efforts in Arnhem Land in the Northern Territory, where a number of promising targets had been previously identified.

Olympic Dam (Roxby Downs) — In June 1985, Western Mining Corporation and British Petroleum Australia announced as expected that the uranium-copper-gold project in South Australia was commercially viable. The joint venture partners established Olympic Dam Marketing Pty. Ltd. to assist with the marketing of the projected output. Later in the year, the partners appointed Kanematsu-Gosho as the sole agents for marketing Roxby Downs uranium in Japan.

Although there was speculation that a final decision might be deferred until firm purchase contracts for the output were obtained, in December the partners announced that the project would in fact proceed. According to the schedule, gold production will begin in 1987 at a rate of 100,000 oz. annually, and copper and uranium production will begin one year later. After extensive studies, including a $15 million pilot plant operation, the partners concluded that the project was viable on a smaller scale than originally envisaged. Although planning continues on the basis that ultimate annual production will amount to 150,000 tonnes of copper and 8.8 million pounds U$_3$O$_8$ plus associated gold, the target output for the first stage will be only 30,000 tonnes of copper and 4.4 million pounds of U$_3$O$_8$. Exploitation of higher grade ore zones will allow the project to start on ore production of 1 million tons per year. The second stage, beginning in the fourth year of production, would double ore production, yielding approximately 55,000 tonnes copper but keeping uranium output at a constant level.

The partners believe that these production targets are appropriate considering the expected market demand. Although it is a co-product of copper mining, the associated uranium is crucial to the economic viability of the project. Although no uranium sales contracts were reported as of the end of 1985, the partners appeared confident that they could place the planned U$_3$O$_8$ output. Indeed, in early 1986 there have been reports that a sales agreement had been reached with the Swedish State Power Board, and another agreement with Britain's Central Electricity Generating Board was expected in the coming months. As of March 1986, however, no agreement between CEGB and an Australian supplier had been announced.

Reserves and Exploration

In early 1985, Australia announced that its Reasonably Assured Resources (RAR) of uranium recoverable at less than US$80 per kilogram (US$30 per pound) U$_3$O$_8$ increased by 12,000 metric tons U (MTU) over the previous twelve months. Total resources of 463,000 MTU represents 29 percent of the free world total. These revisions include changes due to production, exploration, cost increases and exchange rate fluctuations.

Uranium exploration continued in Australia in 1985, albeit on a much smaller scale than in previous years. Some of the companies still pursuing active exploration programs with some success included Total Mining Australia, subsidiary of the French company Total Compagnie Miniere; Japan's Power Reactor and Nuclear Fuel Development Corporation (PNC), and the former owner of Mary Kathleen Uranium, Conzinc Rio Tinto Australia (CRA).

Outlook

Assuming planned capacity increases materialize, Australian production will increase to 17 million pounds by 1988, and to more than 20 million pounds U$_3$O$_8$ by 1993. Whether these targets are realistic, however, will largely depend on the status of the floor price and the strength of the world uranium market in the next five years. Australian producers continue to express confidence about prospects of entering into sufficient long-term contracts to support the announced expansion plans. In general, they expect secondary sources and inventory liquidations to decline, renewing interest in primary producer contracts. Moreover, they believe that with reduced US production, leveling Canadian exports and declining confidence in southern African sources, buyers will increasingly shift their attention to Australia.

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CANADA

Uranium Production

For the second consecutive year, Canada produced far more uranium than any other country in the world. Total 1985 production in Canada amounted to more than 28 million pounds U3O8, equalling the 1984 level and accounting for nearly one-third of total world production. The Key Lake mine in Saskatchewan led Canadian production with slightly more than 11 million pounds U3O8. Eldorado Resources Ltd. produced 2.1 million pounds from its Rabbit Lake operations, and Amok Ltd. produced about the same amount at Cluff Lake. Eldorado ceased mining operations at Rabbit Lake in 1985, and has begun feeding the Rabbit Lake mill with ore from the Collins Bay "B" deposit. Within the province of Ontario, output totaled 13.2 million pounds U3O8: 7.7 million pounds from Rio Algom's Elliot Lake operations and 5.5 million pounds from Denison Mines Ltd.

In recent years, it became apparent that the center of Canadian uranium production in the 1990s will be the province of Saskatchewan. In 1984 and 1985, exploration at the Cigar Lake deposit revealed the largest high grade deposit ever discovered. Even though commercial mining at the project probably will not begin until the early 1990s, the sheer size of the deposit has had a significant influence on the uranium market. Preliminary production plans call for annual output of 12 million pounds U3O8, which probably can be realized by mining 100 tons of ore per day at an average grade of more than 12 percent U3O8. Cigar Lake Mining Company (CLMC), a joint operating company, was formed in May 1985 to identify a suitable mining and milling program for the deposit. It will eventually conduct the mining operations. CLMC is owned by Saskatchewan Mining Development Corporation (SMDC, 50.75 percent), Cogema Canada Ltd. (32.625 percent), Idemitsu Uranium Exploration Canada Ltd. (12.875 percent), and Corona Grande (a wholly owned subsidiary of Cogema), 3.75 percent.

Project development probably will be timed to capture two expected events:

1. The strengthening of the uranium market, which the joint venture partners anticipate will occur in the early 1990s.

2. The sales commitment of all Key Lake output, which will create further Canadian market expansion.

The CLMC pre-development program is tentatively scheduled to complete all studies and secure regulatory approvals by the beginning of 1988. Test mining will continue until the end of 1989. Final development and feasibility planning will begin in 1987 and run through 1990, while actual mine development will begin about 1988 and continue until initial production begins about mid-1993. The final mining plan probably will combine conventional procedures, augmented by techniques designed to overcome the special circumstances of high grade ore and unstable ground conditions. (For a detailed article on the Cigar Lake project, see Report 206, October 1985.)

During 1985, Eldorado Resources' Exploration Division continued drilling on two projects at Eagle Point, 72 kilometers north of the Rabbit Lake mill. As a result, the reserve estimate at the Eagle North deposit, an equal-share joint venture owned by Eldorado Resources, Noranda, and SMDC, was increased to 20,000 MTU at an average grade of 2.6 percent U3O8. The reserve estimate at the Eagle South deposit, wholly owned by Eldorado and adjacent to the Eagle North, was increased to more than 30,000 MTU. Further exploration and definition drilling is in progress at both deposits, and Eldorado has indicated that the development of the deposits will ensure sufficient feedstock to feed the Rabbit Lake mill into the next century.

Eldorado Nuclear Limited concluded the final stage of a major expansion of its Fuel Services Division in 1985, when its Port Hope conversion facility reached commercial production levels. (Report 206 contains an article on Eldorado's conversion operations.) During 1985 Eldorado processed 6,833 metric tons of uranium, a record amount, both as UF6 and UO2 for use in Candu reactors. The record total represented a 55 percent increase over the amount of uranium processed in 1984, when the expansion program was in progress.

Nuclear Power Developments

One Candu reactor entered commercial service in 1985. Ontario Hydro's Bruce Unit 5, a 750 MWe pressurized heavy-water moderated and cooled reactor, entered commercial operation in March 1985. In addition, Pickering Unit 8, the last unit at the 4,720 MWe station, began commercial service in February 1986. Bruce Unit 7 is in the final stages of testing, and Ontario Hydro expects the unit to enter service within weeks (Table 13).

The first four units at the Pickering station had been shut down for extensive tubing repairs throughout 1984 and 1985, but Units 1 and 4 are back in operation, and Units 1 and 2 should be in service by the end of 1986.

The status of Point Lepreau Unit 2 is still uncertain. Plans for the unit, which would have been the first nuclear unit on order in North America since 1978, were designed by Maritime Nuclear, the government-owned company jointly formed by Atomic Energy of Canada and New Brunswick Electric Power Company. The company was created to establish the Point Lepreau Unit 2 project, consisting of a 630 MWe Candu reactor, and it invited contractor proposals in February 1984. The second Point Lepreau unit was intended to supply power exclusively to US markets. However, declining electricity demand and rising construction costs discouraged investment by US utilities. The future of the unit will largely depend on the availability of government financing in addition to commitments from utilities in the northeastern United States to buy the power from the unit.

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CANADA

Table 13

NUCLEAR POWER PLANTS IN CANADA

Utility	Unit	MWe (net)	Percent Complete	COD*
Commercial Operation				
Ontario Hydro	Pickering 1*	515	100	Jul 1971
	Pickering 2*	515	100	Dec 1971
	Pickering 3	515	100	Jun 1972
	Pickering 4	515	100	Jun 1973
	Pickering 5	515	100	May 1983
	Pickering 6	515	100	Feb 1984
	Pickering 7	515	100	Jan 1985
	Pickering 8	515	100	Feb 1986
	Bruce 1	740	100	Sep 1977
	Bruce 2	740	100	Sep 1977
	Bruce 3	740	100	Feb 1978
	Bruce 4	740	100	Jan 1979
	Bruce 6	750	100	Sep 1984
	Bruce 5	750	100	Mar 1985
New Brunswick EPC	Point Lepreau 1	630	100	Jan 1983
Hydro Quebec	Gentilly 2	640	100	Sep 1983
TOTAL		9,850		
Under Construction or Planned				
Ontario Hydro	Bruce 7	750	100	Apr 1988
	Bruce 8	750	85	Jan 1987
	Darlington 1	880	80	May 1988
	Darlington 2	880	40	Feb 1989
	Darlington 3	880	10	Nov 1991
	Darlington 4	880	5	Aug 1992
New Brunswick EPC	Point Lepreau 2	630	0	Indefinite
TOTAL		5,630		

*COD = Actual or Expected Commercial Operation Date
EPC = Electric Power Company
*These units are currently shut down for refitting.

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CENTRAL AFRICA

Gabon

Uranium production in Gabon totaled approximately 2.1 million pounds in 1985, equalling the 1984 level. Comuf (Compagnie des Mines d'Uranium de Franceville) is the owner of the Oklo and Bossindet deposits and the 440,000 MTU capacity Mounana mill. Comuf announced no new plans for expansion or increased production, reflecting the worldwide decline in exploration.

Comuf is owned by a number of interests, including Compagnie Francaise Minière (79 percent), which operates the project, Cogema (16.8 percent), Pechiney (3 percent) and the Gabonese public (4.4 percent). The company leases a 1,250 square kilometer concession area originally granted by the government of Gabon to the French CEA (Commissariat a l'Energie Atomique). Gabonese uranium production is largely captive; most Mounana output goes to Cogema, while other European and Japanese buyers receive deliveries under short and medium-term contracts.

The French nuclear supplier Sofratome and the Gabonese government continued discussions regarding the construction of a nuclear power plant in Gabon. Historically, about half of Gabon's imports have come from France, while about one-fourth of its exports, primarily oil and uranium, go to France each year. The nuclear unit would be part of a comprehensive, five-year development plan in the late 1980s.

Also in 1985, the completion date for the Trans-Gabonais railway was advanced from August 1987 to December 1986. The 112 kilometer line between the uranium production center of Mounana-Franceville and Booue (currently the end of the northern part of the railway, originating at the port of Owendo) will facilitate the transport of uranium and other goods.

Niger

Niger's uranium operations produced 8.5 million pounds U3O8 in 1985, almost equalling the 1984 level. The state-company Cmapagnie d'Etat National des Ressources Minières) has an interest in both of the operating projects the Akouta and Arlit mines.

The underground mine at Akouta, which began production in 1978, produces slightly more than half of Niger's uranium. The project is owned by Cominak (Compagnie Minière d'Akouta) its shareholders are: Cogema (34 percent), Onarem (31 percent), Japan's Overseas Uranium Resources Development Company (25 percent) and the Spanish fuel-cycle company Enusa (Empresa Nacional del Uranio S.A.), (10 percent). Cogema operates the mine and purchases approximately half of the output. The Arlit project is an open-pit mine covering three related sedimentary deposits. The project is owned by Somair (Société des Mines de L'Air) and operated by Cogema. Somair's shareholders are: Onarem (33 percent), Cogema (27 percent), Compagnie Francaise Minière (19.4 percent), Pechiney (7.6 percent), Germany's Urangesellschaft mbH (6.5 percent), and Italy's Agip Uranio (6.5 percent).

The 1985 published contract price for Niger uranium was only 2.5 percent to 30,000 CFA per kgU, for 1985 deliveries, a smaller increase than in 1983 (14.5 percent) or 1984 (6.4 percent). Although current project reserves amount to approximately 300,000 metric tons of uranium, it appears unlikely that any expansion of production efforts will take place in Niger until new buyers demonstrate a willingness to accept the price which is established annually. Onarem continued active marketing of its share of production, both directly and as possible feeder for development projects in Niger.

EUROPE

Introduction

Seventeen European countries in 1985 continued their record of success in nuclear power. Nuclear-generated electricity accounted for more than 25 percent of Western Europe's total electricity production; in France, the industry leader, the share of domestic nuclear power rose to 70 percent of total generation from some 42 operating units. In Germany, Spain and Britain nuclear capacity grew steadily, reflecting utility experience and the increasing stability of the industry. In Britain, Italy, the Netherlands and Switzerland, plans to build new light-water reactors finally moved ahead after years of delay. Figure 2 shows the distribution of nuclear energy in Europe and the current contribution of the nuclear sector to overall electricity generation. The map illustrates the growing importance of nuclear energy to the economy of Europe as a whole.

AUSTRIA

Austria's only nuclear power station, a completed 740-MWe BWR located near the village of Zwentendorf, has been mothballed since 1978, when in a popular referendum voters enacted an operation by the narrow margin of 50.47 to 49.53 percent. The Kraftwerk Union unit cost more than US$700 million equivalent to build, and OKT (Gemeinschaftskraftwerk Tullnerfeld GmbH), the consortium owning the plant, has spent several million dollars annually to maintain it over the past seven and a half years. During that time OKT has invested opportunities to sell components and other large assets, hoping for a change of public opinion with time to reverse the 1978 decision.

The latest attempt to reverse the 1978 decision occurred in March 1985, when the Austrian parliament voted on a proposal to hold a new public referendum on the issue. The proposal failed to receive support from two-thirds of the legislature, so no new referendum will be held under the current government, which will remain in office until general elections in mid-1987. The OKT board of directors held discussions following the spring vote and decided again to study the options for liquidation or continued plant maintenance. In November 1985 the company contracted with Electric Power Corporation (USA) to conduct a private study of the market value of the assets. The Electric report is scheduled to be completed in June 1986, and OKT will then decide whether to proceed with liquidation or to wait for the next opportunity to present its case to parliament.

Undoubtedly the sale of the Zwentendorf plant would result in a huge financial loss for OKT. The loss would be particularly unsettling because the plant's power is needed if Austria is to reduce its dependence on foreign electricity imports (particularly from Czechoslovakia) which supply a mounting share of electricity consumption. Industrial leaders have had trouble persuading the public sector to proceed with any new power projects, however. During 1985 the region rejected construction of a large hydroelectric dam on the Danube, and new oil-fired and coal-fired power plants are highly controversial in Central Europe because of the dying forest problem.

BELGIUM

The final two units in Belgium's seven-unit nuclear power program entered commercial service during 1985, ending the nation's plant construction phase. Doel Unit 4 and Tihange Unit 3, both 890-MWe PWRs, reached full power on June 20 and July 23, respectively. The current phase of Belgium's nuclear program is now complete, totaling a net capacity of 5,425 MWe and accounting for as much as 90 percent of the country's generation when all seven units are at full power. The operating history for all of the units has been exceptional, with capacity factors consistently above 65 percent. (See Report 205 for an article on nuclear energy in Belgium.)

Belgian interests own shares in three nuclear units outside the country which were under construction during 1985. Chooz Unit B1, a 1,355-MWe PWR under construction in France near the Belgian border, is a joint Franco-Belge project begun in 1984. Belgian companies are supplying 22.5 percent of construction orders and will receive 25 percent of the power at cost when the unit enters operation. Belgium's Electricite de France owns 44.75 percent of the Kalkar 300-MWe Fast Breeder Reactor in Germany, now nearing completion, and 2.4 percent of Superphenix, the 1,200-MWe FBR in France that was completed in late 1985.

Synatom, the fuel cycle company handling all of Belgium nuclear requirements, made no contractual announcements during 1985 related to natural uranium or enrichment services. The company continued to replenish stockpiles under long-term contract with producers in Australia, Canada, and Africa, and made some discretionary purchases in the spot market. Having exchanged SWU deliveries from the US DOE prior to 1985, Synatom took enrichment services principally from Eurodif, of which it is a shareholder. Synatom's subsidiary Belgoprocess, responsible for domestic reprocessing and in particular the revival of the Eurochemic plant at Dessel, continued to study the feasibility of the project.

FINLAND

Finland's four nuclear power units operated reliably during 1985, as they have for the past several years, supplying more than 17 percent of the nation's electricity production. Capacity factors

Figure 2
PERCENT OF TOTAL ELECTRICITY GENERATION FROM NUCLEAR POWER STATIONS
As of December 31, 1985

for the two 445-MWe Soviet PWRs at IVO's Ulvinsalo Voima Oy) Loviisa station exceeded nameplate during several months of the year. Load factors were also high for Olkiluoto Units 1 and 2, the 719-MWe Asea-Atom BWRs operated by TVO (Teollisuuden Voima Oy). Both TVO units recorded exceptionally short refuelling outages; for Unit 1 refuelling lasted only 16 days, while the outage for Unit 2, including complete retubing of the condenser, lasted 29 days.

Although it has been discussed for several years, no new nuclear unit was ordered in Finland during 1985. Eventually a fifth unit probably will be built, given the country's favorable experience with nuclear power and the apparent need for more generating capacity. Finnish electricity consumption has been growing during the past few years at a rate of about 4 percent annually. During 1985 no significant change in the country's nuclear fuel supply situation was reported. TVO accepted uranium deliveries under long-term contracts from Canada and Australia; enrichment requirements for all four of the country's units are still covered by the USSR.

FRANCE

Nuclear Power Developments

Electricite de France's (EDF) unparalleled nuclear generating capacity continued to grow during 1985 as four new PWRs entered commercial operation and five other units were connected to the grid. Total installed nuclear capacity in France presently amounts to some 37,698 MWe, while 23,520 MWe are under construction or undergoing power testing (Table 14 and Figure 3). Perhaps the most notable achievements for the year was the commercial operation of the first of Framatome's 1,300-MWe rated PWRs, located at the Paluel station in Normandy. Despite some initial technical problems with the new series, four other 1,300-MWe units were connected to the grid in 1985 and scheduled for commercial operation in the first half of 1986. In addition, during 1985 EDF began operating the sixth 900-MWe PWR at the Gravelines station (5,460 MWe), also in Normandy.

Nuclear power stations supplied some 65 percent of total French electricity production, while hydroelectric plants produced slightly more than 20 percent and conventional thermal plants supplied the balance. EDF exported approximately 22,000 GWh (net), some 12 percent of its total production during the year, to Germany, Switzerland, Italy, Spain and Belgium. Much of the exported power was sold under seasonal or spot contracts; consequently EDF's nuclear units, which are favored for baseload demand, supplied about 70 percent of French domestic consumption and a lower fraction of the exported power.

Despite these optimistic figures, the eighteen PWRs under construction and a surplus of capacity present a mounting challenge to EDF to fully utilize its nuclear power investment. The government recently restricted the number of new plant orders to one per year, down from six per year less than a decade ago. That decision threatens the future of French manufacturers like Framatome and Alsthom, and it does not address EDF's immediate overcapacity problem. The utility's average electricity prices are well below those in most industrial countries in order to promote domestic consumption. Concurrently, it has introduced a complex rate incentive system designed to encourage off-peak power use and increase baseload demand. Since dramatic changes in electricity consumption patterns are unlikely during the next few years, however, EDF has also pioneered technical means to modulate power output at its nuclear plants to accommodate short-term demand fluctuations.

The export market is important to the French, and EDF's surplus generating capacity ultimately makes economic sense in the context of the entire European market. All of France's bordering neighbors are currently net importers of electricity from EDF; Britain may become one soon as well, as the first half of the 2,000-MWe grid link under the English Channel will begin exchanging power between the two nations in 1986. For EDF, the preferred form of export contract is direct foreign investment in its power stations, such as those made by Belgian, Italian and German utilities in the Chooz, Bugey, Fessenheim and Cattenom plants. Investments in EDF's plants may be highly attractive to European utilities having difficulty installing new generating capacity on their own soil, a problem still prevalent outside of France.

Fuel Developments

Natural uranium production in France from six mills, two operated by Total Compagnie Minieres and four by Cogema or its subsidiaries, amounted to approximately 4 million pounds U3O8 in 1985. Total's St. Pierre facility was shut down in mid-year, but the closure will not significantly affect the company's domestic output. Total owns 10 percent of the Rossing mine in Namibia and sold its share of production in 1985 under long-term arrangements. In addition to its domestic operations, Cogema is the operator or leading commercial shareholder of the Cluff Lake project in Canada, Comurhak and Somair in Niger, and Comuf in Gabon; it is also the parent company of Pathfinder Mines in the USA and the operator of the Cigar Lake project in Saskatchewan, through its subsidiary Cogema Canada Ltd. Development work at Cigar Lake during 1985 continued to reveal extraordinary results (see Report 206 of October 1985 for an article on the Cigar Lake deposit).

Figure 3

NUCLEAR PLANT SITES AND URANIUM PRODUCTION CENTERS IN FRANCE

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EUROPE

Table 14

NUCLEAR POWER STATIONS IN FRANCE

Unit	Net MWe	Type	COD	Percent Complete
Belleville 1*	1275	PWR	1988	80
Belleville 2*	1275	PWR	1988	70
Blayais 1	910	PWR	1981	100
Blayais 2	910	PWR	1983	100
Blayais 3	910	PWR	1983	100
Blayais 4	910	PWR	1983	100
Bugey 1	540	GCR	1972	100
Bugey 2	920	PWR	1979	100
Bugey 3	920	PWR	1979	100
Bugey 4	900	PWR	1979	100
Bugey 5	900	PWR	1980	100
Cattenom 1*	1265	PWR	1987	85
Cattenom 2*	1265	PWR	1987	75
Cattenom 3*	1265	PWR	1989	50
Cattenom 4*	1265	PWR	1990	30
Chinon A3	400	GCR	1967	100
Chinon B1	870	PWR	1984	100
Chinon B2	870	PWR	1984	100
Chinon B3*	870	PWR	1987	90
Chinon B4*	870	PWR	1987	70
Chooz A1	310	PWR	1967	100
Chooz B1*	1400	PWR	1991	20
Civaux 1	880	PWR	1993	100
Civaux 2	880	PWR	1994	100
Civaux 3	880	PWR	1994	100
Civaux 4	880	PWR	1994	100
Dampierre 1	890	PWR	1980	100
Dampierre 2	890	PWR	1981	100
Dampierre 3	890	PWR	1981	100
Dampierre 4	890	PWR	1981	100
Fessenheim 1	880	PWR	1977	100
Fessenheim 2	880	PWR	1979	100
Flamanville 1*	1290	PWR	1986	80
Flamanville 2*	1290	PWR	1986	40

See footnotes next page

Table 14

NUCLEAR POWER STATIONS IN FRANCE (continued)

Unit	Net MWe	Type	COD	Percent Complete
Golfech 1*	1275	PWR	1990	30
Golfech 2*	1275	PWR	1991	15
Gravelines B1	910	PWR	1980	100
Gravelines B2	910	PWR	1980	100
Gravelines B3	910	PWR	1981	100
Gravelines B4	910	PWR	1981	100
Gravelines C5	910	PWR	1984	100
Gravelines C6	910	PWR	1985	100
Marcoule G2	40	GCR	1959	100
Phenix	233	LMFBR	1973	100
Nogent sur Seine 1*	1275	PWR	1988	70
Nogent sur Seine 2*	1275	PWR	1989	55
Paluel 1	1290	PWR	1985	100
Paluel 2	1290	PWR	1986	100
Paluel 3	1290	PWR	1986	100
Paluel 4*	1290	PWR	1986	95
Penly 1*	1290	PWR	1987	45
Penly 2*	1290	PWR	1991	20
St. Alban 1	1300	PWR	1986	100
St. Alban 2*	1300	PWR	1986	90
St. Laurent A1	480	GCR	1969	100
St. Laurent A2	515	GCR	1971	100
St. Laurent B1	880	PWR	1983	100
St. Laurent B2	880	PWR	1983	100
Superphenix[2]	1200	LMFBR	1986	100
Tricastin 1	915	PWR	1980	100
Tricastin 2	915	PWR	1980	100
Tricastin 3	915	PWR	1981	100
Tricastin 4	915	PWR	1981	100
Total MWe[3]	61,208			

*Unit under construction.
[1]Classic Unit A is owned and operated by SENA (Société Nucléaire Franco-Belge des Ardennes), owned 50 percent each by EDF and the Belgian utilities.
[2]Superphenix is owned by NERSA, a European consortium of which the shareholders are EDF (51 percent), ENEL (33 percent), and SBK (16 percent). SBK is owned by RWE (FRG, 58.75 percent), SEP (Netherlands, 14.75 percent), Electrabel/Intercom (Belgium, 14.75 percent), and CEGB (UK, 11.75 percent).
[3]Excluded from this list are Classic A2, Marcoule G3, and Molten Salt Fuel, which are undergoing decommissioning, and Chooz B2, which has not been officially ordered.

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The bulk of EDF's 1985 requirements were supplied under long-term arrangements with Cogema and Total. Its long-term contract with Queensland Mines Ltd. of Australia was suspended in 1984 when the Australian government enacted a uranium boycott against France to protest French nuclear weapons tests in the South Pacific. No progress in removing the boycott was reported during 1985. The French government imposed economic sanctions against South Africa during 1985 to protest political repression in that country. Among other measures, the sanctions prevent EDF from signing new supply contracts with South Africa or Namibian uranium producers.

The French conversion Comurhex produced approximately 8,500 MTU as UF6 in 1985, equaling 1984 production, while reporting a strengthening in the intermediate-term market for its services (*Report* 205 - 7 September 1985 - contains an article on Comurhex). Comurhex also continued development plans for Usine 2000, a commercial reconversion plant for the treatment of depleted uranium and low-enriched uranium in various forms. As the service shareholder of Eurodif, Cogema marketed enrichment services internationally and announced progress from research into laser enrichment methods. Eurodif's diffusion plants operated at about 65 percent of capacity for most of the year, a level likely to increase in 1986 as new contracts begin to take effect. Cogema speculated that its SILVA laser enrichment program would be commercially applicable toward the end of the century, and that SWU prices then would be much lower than at present, an assessment similar to that made by DOE. Construction progressed on 1985 on Cogema's CFP reprocessing plant at La Hague, which completed in 1989, the plant will have nine capacity to 1,600 MTU annually.

FEDERAL REPUBLIC OF GERMANY

Three Kraftwerk Union (KWU) units entered commercial operation during 1985, increasing installed nuclear capacity to 16,095 MWe from eleven units, with seven units (6,865 MWe) still under construction or undergoing power testing (Table 15). The eleven commercial units now supply on average 35 percent of total West German electricity generation, while accounting for roughly 20 percent of installed electrical capacity. The three units entering commercial operation were Grohnde, managed by Preussenelektra AG; Gundremmingen Unit C, managed by RWE (Rheinisches-Westfaelisches Elektrizitaetswerk AG); and Philippsburg Unit 2, managed jointly by Badenwerk AG and EVS (Energie Versorgung Schwaben AG) (Figure 4). C... tion to the grid of the THTR (Thorium High Temperature ... tor) in North Rhine Westphalia was delayed several times until late summer, when the operators received a low-power operating license. Since then the operating consortium, led by VEW (Vereinigte Elektrizitaetswerke Westfalen AG), has increased a full power operating license, and commercial operation is imminent.

KWU's work on ... water reactors in the West German backlog proceeded smoothly during the year. RWE's Kuerfach plant, a Babcock Brown Boveri unit, is scheduled to begin operation this summer, and the entire backlog should be producing electricity by the end of the decade. Both RWE and Preussenelektra have indefinite plans to build additional nuclear units. RWE has an excess of electrical capacity and probably will refrain from placing orders for Neupotz or Muelheim-Kaerlich for several years. Preussenelektra applied to the state government of Hesse late in 1985 for approval to build its long-delayed Borken unit, which it wants to replace a lignite power station located at a site that has been attacked because of air pollution. However, the current Hessian government is led by the Social Democratic Party in coalition with the anti-nuclear Green Party, so the probability that it will grant the licenses necessary to build the plant appears to be low.

Nordwestdeutsche Kraftwerk AG (NWK) and Preussische Elektrizitaetswerk AG (PREAG) merged in the third quarter of 1985 to form Preussenelektra AG (PE). Prior to the consolidation, PREAG had owned about 70 percent of NWK. The consolidated utility, controlled by the holding company Veba AG, is now the second biggest electricity producer in Germany after RWE. It also has the largest service territory, stretching from the Danish border in the north as far as Frankfurt in the south. Nearly all of the utility's baseload generation is supplied from the six operating nuclear units in which it has an interest. PE's Grohnde unit produced 11.49 billion kilowatt hours in 1985, a world record for a single unit.

The decline of KWU's domestic reactor market led it to pursue orders aggressively outside of Europe during 1985, particularly in the People's Republic of China. The German utilities have supported KWU's efforts by considering to buy Chinese uranium destined for KWU plants. While no agreement between the German vendor and China has been announced, GKN (Gemeinschaftskernkraftwerk Neckar GmbH) announced at year-end that it had reached agreement with China for a long-term U3O8 supply arrangement. In other natural uranium developments, the German utility retained a long-term agreement with Nufcor of South Africa, while another utility purchased its near-term requirements from Key Lake producers, and a few small spot sales to German utilities were reported. Several of the utilities have supply arrangements with German uranium companies (Figure 5).

Most of the German utilities now have contracts to receive at least some enrichment services from Urenco, the British-Dutch-German centrifuge enrichment consortium. Urenco's German plant, located at Gronau near the Dutch border, began commer-

cial production in August 1985 from its first cascade module, which has a capacity of 100,000 SWU per year. Additional modules at Gronau are under construction; the consortium's goal is to have four modules in service by 1988 and ten in service by 1995. In addition to contracts with Urenco, one West German utility has a long-term contract with Eurodif, while GKN, RWE and Bayernwerk each have long-term SWU contracts with the USSR, and two of Preussenelektra's units are covered by DOE Utility Services Contracts for the long term. Also in 1985, construction began on Germany's planned reprocessing plant at Wackersdorf in Bavaria, despite heavy activity by interveners.

Table 15

NUCLEAR POWER UNITS IN THE FEDERAL REPUBLIC OF GERMANY

Lead Utility and Fuel Buyer	Unit	MWe	Type	COD	Percent Complete
BW-EVS	Philippsburg 1	864	BWR	1980	100
	Philippsburg 2	1268	PWR	1985	100
BAG	Grafenrheinfeld	1215	PWR	1982	100
	Isar 1	870	BWR	1979	100
	Isar 2*	1285	PWR	1988	70
GKN	GKN 1	795	PWR	1976	100
	GKN 2*	1230	PWR	1989	50
HEW	Brokdorf*	771	BWR	1987	0
	Krümmel	1290	BWR	1984	100
KWO	Obrigheim 1	328	PWR	1969	100
Preussenelektra	Würgassen	640	BWR	1972	100
	Stade	630	PWR	1972	100
	Unterweser	1230	PWR	1979	100
	Grohnde	1256	PWR	1985	100
	Brokdorf*	1290	PWR	1986	0
RWE	Biblis A	1146	PWR	1974	100
	Biblis B	1240	PWR	1976	100
	Gundremmingen B	1244	BWR	1984	100
	Gundremmingen C	1244	BWR	1985	100
	Kamlich*	1227	PWR	1986	100
SBK	Kalkar*	295	LMFBR	1987	95
VEW	THTR 300	296	HTR	1985	100
	Emsland*	1290	PWR	1988	50
Total		21,729			

*Unit under construction

BW = Badenwerk AG
BAG = Bayernwerk AG
EVS = Energieversorgung Schwaben AG
GKN = Gemeinschaftskernkraftwerk Neckar GmbH
HEW = Hamburgische Elektrizitätswerke AG
KWO = Kernkraftwerk Obrigheim GmbH
RWE = Rheinisch-Westfälisches Elektrizitätswerk AG
SBK = Schnell Brüter Kernkraftwerksgesellschaft mbH
VEW = Vereinigte Elektrizitätswerke Westfalen AG

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Figure 4

NUCLEAR POWER PLANT OWNERSHIP
IN THE FEDERAL REPUBLIC OF GERMANY

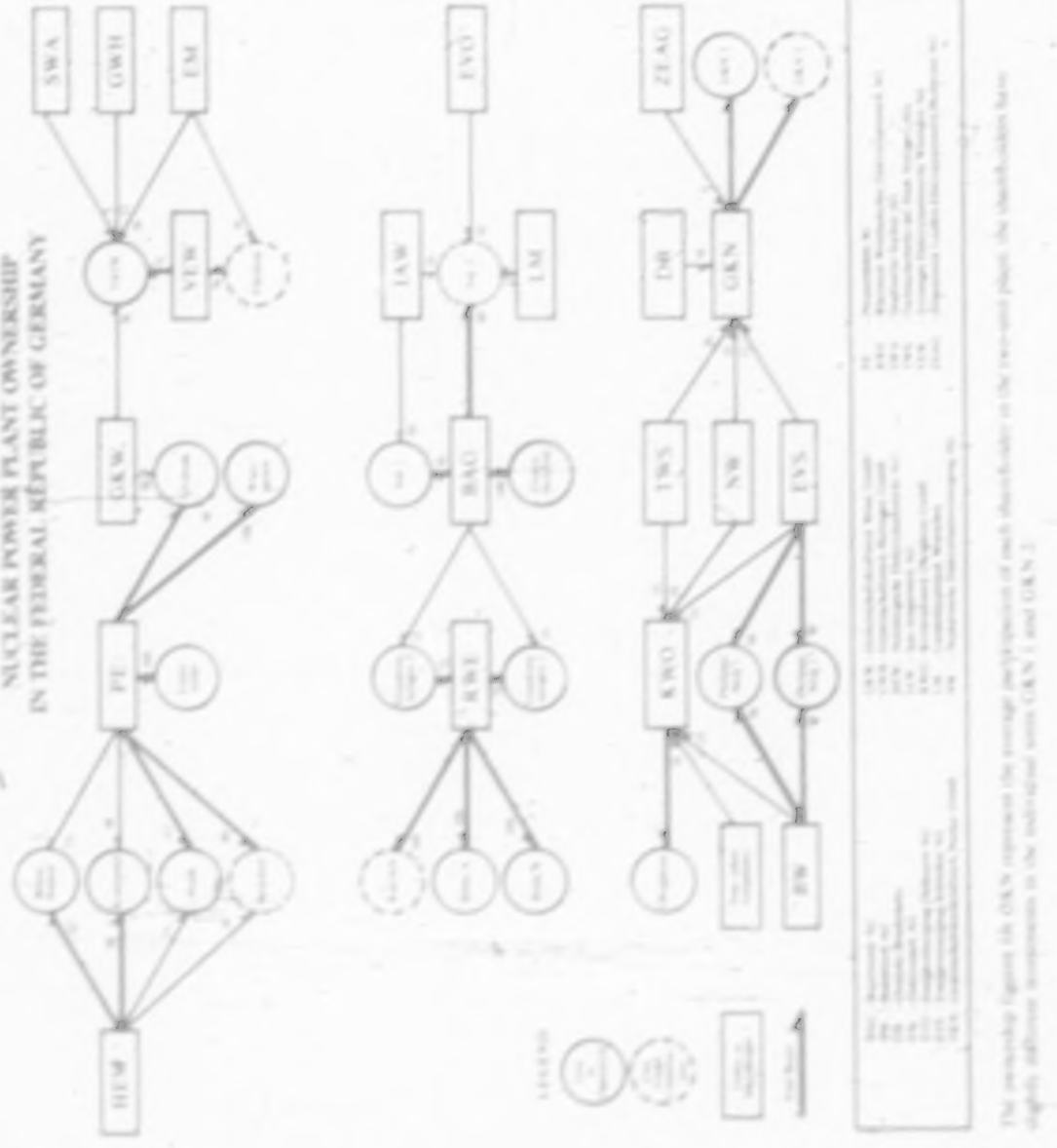
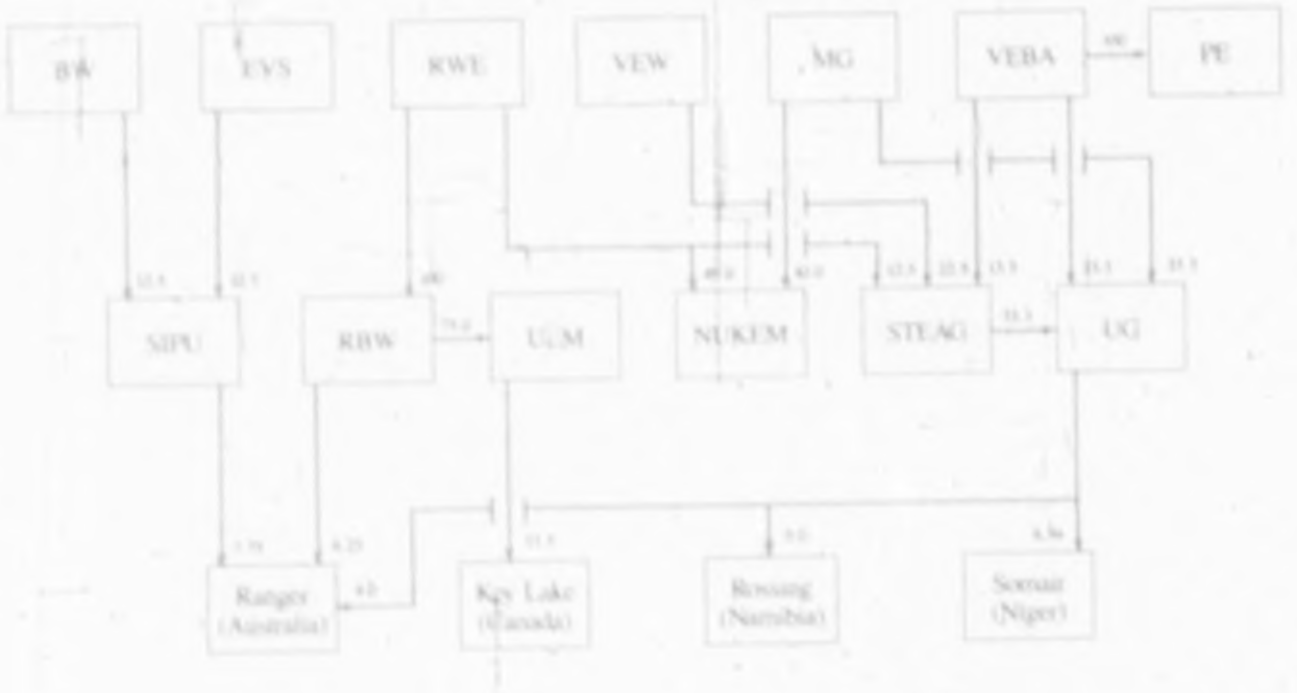


Figure 5

GERMAN OWNERSHIP IN ACTIVE
URANIUM PRODUCTION AND TRADING OPERATIONS



BW — Badenwerk AG
EVS — Energieversorgung Schwaben AG
MG — Metallgesellschaft AG
NUKEM — Nukem GmbH
PE — Preussenelektra AG
RBW — Rheinische Braunkohlenwerke AG
RWE — Rheinisch-Westfälisches Elektrizitätswerk AG
SIPU — Saarberg Interplan Uran GmbH
STEAG — Steag AG
UGM — Urangesellschaft mbH
UG — Urangesellschaft mbH
VEBA — Veba AG
VEW — Vereinigte Elektrizitätswerk Westfalen AG

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ITALY

Until its 1985 ENEL (Ente Nazionale per l'Energia Elettrica), Italy's state utility, made the first concrete step in twelve years toward the expansion of its nuclear power capacity when it signed a contract with Ansaldo Meccanico Nucleare SpA, the Italian reactor supplier, to build two 975-MWe PWRs at the Trino Vercellese site in Piedmont. Civil engineering work is scheduled to begin in mid-1987, and commercial operation dates are planned for 1994. ENEL last ordered a reactor in 1973, when it contracted for the two-unit Montalto di Castro BWR station in Latium, now approximately 40-percent complete and scheduled to enter service in 1990. One 875-MWe BWR, located on the Po River at Caorso near Piacenza, has been in commercial operation in Italy since 1981, and two smaller units, a 260-MWe PWR at Trino and a 150-MWe GCR near Latina, have been in operation since the mid-1960's.

Italy's nuclear power program has a more pronounced history of delays than any other European country, a fact that has influenced the nuclear fuel market over the past several years. To some degree, the delays may be attributable to unrealistic planning by the Italian government. The government's most recent National Energy Plan, passed in 1981, calls for installment of 12,000 MWe of nuclear capacity by 1990, or eleven 1,000-MWe units in eight years. One major cause of delay was public opposition to new plant construction projects. In December 1985, 96 percent of voters in a region of Calabria rejected ENEL's proposal to build a four-unit coal station. Approval in most parts of Italy for nuclear projects has been equally elusive. The utility obtained local backing for the new Trino units mainly for two reasons: the site already has a PWR in operation, and the government offered a number of economic incentives to the region.

ENEL's problems in developing new nuclear and coal stations on a large scale has left it among the business users of fuel oil for electricity production in Europe. The recent dramatic slump in oil prices has made oil-fired plants more acceptable economically, though environmentally they remain unattractive. In fact, ENEL's existing installed generating capacity is adequate to supply all of the country's current electricity needs, and the utility is importing a substantial share of its needs rather than employing all of its capacity. ENEL took advantage of EDF's excess capacity during 1985, receiving more than 6,500 GWh of power from France.

NETHERLANDS

1985 was a long-delayed year for the Dutch electricity sector, as the parliament approved a plan to install at least 2,000 MWe of nuclear generating capacity by 1995. Dutch utilities had been hindered by anti-nuclear politics since the mid-1970s, when a government plan to construct 3,000 MWe of nuclear capacity was shelved due to political controversy. By contrast, opposition to the 1985 decision has been relatively quiet in a country known for its ecologist and pacifist movements. Dutch public opinion, measured in a lengthy survey on energy sponsored by the government and completed in January 1984, still favors "soft" energy sources over additional nuclear or coal plant construction. However, the government expects the country to need between 8,000 and 10,000 MWe in new generating capacity by 2000, a target impossible to reach by adding only renewables and combined heat and power. Thus, in January 1985 the cabinet issued its plan to build new nuclear units. Parliament approved the plan in June, and in January 1986 approved the government's site recommendations for the new units, paving the way to ordering the units.

The government recommended three sites in order of preference: the favored site being Borssele in Zeeland, in the southwest corner of the country, where the Netherlands' largest existing nuclear unit has been operating since 1973. The unit, a 445-MWe Kraftwerk Unions PWR operated by PZEM (Provinciale Zeeuwse Energie Maatschappij), has a successful operating history. (The only other commercial unit in the Netherlands is a 55-MWe BWR located at Dodewaard.) The other sites recommended by the government were at Moerdijk, south of Rotterdam, and near Delfzijl at the country's northern tip. Site selection is scheduled to be completed in April prior to general parliamentary elections in May 1986.

If the station is built at Borssele as expected, a consortium of three southern utilities including PZEM is likely to be the owner-operator. The Netherlands' thirteen provincial utilities have been planning mergers for some time, the effect of which will be to create three or four large utilities, the consortium owning the future Borssele station could become a single utility if the mergers plans are eventually realized. The invitation for bids to build the new units is scheduled for April 1986, while the plant orders and license applications are expected in late 1987.

The Dutch parliament placed one condition on its approval of the nuclear energy plan: that an acceptable solution to the long-term disposal of spent fuel be found prior to the granting of any licenses. Thus, while formalizing their construction plans during the next eighteen months, the utility group will also develop a proposal for closing the fuel cycle in the Netherlands. One other uncertainty remains: if an anti-nuclear political coalition wins the May 1986 parliamentary elections, the parliament could reverse the 1985 decision. The pro-nuclear coalition of Christian Democrats and Liberals currently has a majority of 81 votes in the 150-seat assembly.

PORTUGAL

Empresa Nacional de Uranio's (ENU) uranium mill at Urgeirica produced approximately 300,000 pounds U3O8 during 1985, roughly the same amount as in 1984. ENU currently mills ore from six sedimentary deposits at the northern part of the country. Portugal's reasonably assured uranium resources total nearly 20 million pounds U3O8. Government officials held talks during 1985 with Atomic Energy of Canada Ltd. (AECL) regarding the possibility of building Candu nuclear stations in Portugal. The government apparently favors the Candu over light-water reactors because it uses natural uranium fuel, eliminating the need for foreign enrichment contracts. AECL is scheduled to complete a feasibility report early this year on the construction of up to four units. Portugal joined the European Economic Community on January 1, 1986, bringing the nation's nuclear related activities under the jurisdiction of the Euratom organization.

SPAIN

Two nuclear units entered commercial operation during 1985, increasing total installed nuclear generating capacity in Spain to 5,662 MWe produced by eight units (Table 16 and Figure 6). Cofrentes, a 975-MWe General Electric BWR operated by Hidroelectrica Espanola SA., began commercial generation in March, and Asco Unit 2, an 897-MWe PWR owned by a consortium of four utilities, began service in June. Two additional units, Trillo Unit 1 and Vandellos Unit 2, are under active construction and scheduled to be completed in 1987. After that time, no new units are likely to enter operation before at least the mid-1990s. Construction work on Lemoniz Units 1 and 2 and Valdecaballeros Units 1 and 2, a total of 3,750 MWe of capacity, has slowed considerably since the government announced its national energy plan in 1984 which deems over 30 GWe of new units for at least the next seven years.

Table 16

SPAIN'S REVISED NUCLEAR POWER PROGRAM

Unit	Utility	MWe	Type	COD
Operating				
Jose Cabrera[1]	UE	150	PWR	1968
Garona	Nuclenor	440	BWR	1971
Vandellos 1	Hifrensa	480	GCR	1972
Almaraz 1	HE/CSE/UE/Iberduero	930	PWR	1981
Almaraz 2	HE/CSE/UE/Iberduero	930	PWR	1983
Asco 1	Fecsa/Enher[2]	897	PWR	1984
Asco 2	Fecsa/Enher/HC/FES	897	PWR	1985
Cofrentes	HE	975	BWR	1985
TOTAL		5,662		
Under Construction				
Trillo 1	UE/Iberduero	997	PWR	1987
Vandellos 2	Enher/HC/Enher[2]	982	PWR	1987
TOTAL		1,979		
Indefinitely Deferred				**Percent Complete**
Lemoniz 1	Iberduero	930	PWR	95
Lemoniz 2	Iberduero	930	PWR	90
Valdecaballeros 1	HE/CSE	975	BWR	80
Valdecaballeros 2	HE/CSE	975	BWR	45
TOTAL		3,750		

[1] Also known as Zorita.
[2] Enher is Iberduero interest.

UE = Unigas Electrica Fenosa SA
Nuclenor = Centrales Nucleares del Norte SA
Hifrensa = Hispano-Francesa de Energia Nuclear SA
HE = Hidroelectrica Espanola SA

CSE = Compania Sevillana de Electricidad SA
Fecsa = Fuerzas Electricas de Catalunya SA
Enher = Empresa Nacional Hidroelectrica Ribagorzana SA
HC = Hidroelectrica de Catalunya SA
FES = Fuerzas Electricas del Segre SA

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Figure 6

DISTRIBUTION OF NUCLEAR UNITS AND URANIUM
PRODUCTION AREAS IN SPAIN AND PORTUGAL

The Spanish electric utility industry implemented a restructuring program during 1987 designed by the government to improve efficiency and balance capacity holdings among the principal regional utilities. One of the direct results of the restructuring has been to alter the ownership of several nuclear units, in particular by granting shares in these units to the principal utility in the country's industrial north, Iberduero SA, partly as compensation for capacity it has lost through the shifting of the two-unit Lemoniz plant (Table 17). The state utility Endesa also acquired shares in two nuclear units, while Union Electrica Fenosa divested itself of approximately half of its ownership in the Ascoy plant. Several of the country's plants are owned by utility consortia.

Table 17

RECENT CHANGES IN UTILITY HOLDINGS OF NUCLEAR UNITS IN SPAIN

Unit	Owners in 1985	Percent	Owners in 1986	Percent
Jose Cabrera	UE-Fenosa	100	unchanged	
Garona	Nuclenor	100	unchanged	
	(50% Elec. de Viesgo)			
	(50% Iberduero)			
Vandellos 1	Hidrola	100	unchanged	
	(25% Esther)			
	(25% Fecsa)			
	(25% HC)			
	(25% EDF)			
Vandellos 2	Endesa-Esther	54	Endesa-Esther	75
	HC	29	HC	25
	Segre	10		
	Fecsa	7		
Almaraz 1 & 2	Hidrola	11.1	Hidrola	36
	Sevillana de Electricidad	11.1	Sevillana de Electricidad	36
	UE	11.1	UE	11.1
			Iberduero	11.1
Asco 1	Fecsa	100	Fecsa	60
			Endesa	40
Asco 2	Esther	40	unchanged	
	Fecsa	40		
	HC	17		
	Segre	3		
Cofrentes	Hidrola	100	unchanged	
Trillo 1	UE	80	UE	40.5
	Endesa	20	Iberduero	40.5
			E. Castellonense	7

EDF = Electricite de France
Endesa = Empresa Nacional de Electricidad
Esther = Empresa Nacional Hidroelectrica Ribagorzana
Fecsa = Fuerzas Electricas de Cataluna SA
HC = Hidroelectrica de Cantabrico
Hidrola = Hidroelectrica Española
Hidronor = Hispano Francesa de Energia Nuclear SA
Nuclenor = Centrales Nucleares del Norte
Segre = Fuerzas Hidroelectricas del Segre
UE = Union Electrica-Fenosa

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Spain became a member of the European Economic Community (EEC) on January 1, 1986, and is now part of Euratom, the EEC atomic energy treaty organization. Spain's entrance into the EEC will accelerate economic integration with other European countries, and may increase Spanish participation in European electricity and nuclear energy projects. Currently the Spanish state uranium company Enpsa (Empresa Nacional de Uranio SA) owns 11.11 percent of Eurodif, which includes power from EDF's 3,660-MWe Tricastin station; Spanish utilities are importing power from EDF both in lieu of electricity due at Eurodif and under other contracts. EDF in turn imports power from Spain in accordance with its 25 percent ownership in Vandellos Unit 1, a 480-MWe GCR located near Barcelona.

Enusa produced approximately 500,000 pounds U_3O_8 in 1985 at its Ciudad Rodrigo conventional mill and heap leaching facilities near Salamanca. The company plans to expand domestic production operations over the next several years as foreign supply obligations end and inventories decrease. The general plan to produce 1,000 tons U_3O_8 annually by the early 1990's would lessen foreign expenditures and increase self-sufficiency in the fuel cycle. Spain has reasonably assured uranium resources in excess of 35 million pounds U_3O_8, most of which are concentrated in the province of Salamanca. During 1985 Enpsa purchased natural uranium from Cominak in Niger, of which it is a 10 percent owner, and from Canadian and African producers. Enrichment was supplied by DOE, Eurodif and the USSR. The country's first domestic fuel fabrication plant began commercial assembly at Juzbado in 1985.

SWEDEN

The Swedish nuclear power program reached maturity during 1985 as the country's last two units, Oskarshamn Unit 3 and Forsmark Unit 3, and CLAB, the centralized spent fuel storage facility, all entered commercial operation. Oskarshamn Unit 3 and Forsmark Unit 3 are both 1,050-MWe BWRs supplied by Asea Atom; after weeks of power testing and pre-commercial overhaul, the two units were brought into service together on August 21. CLAB began storage operations on July 11. At the end of 1985 the country's 12 nuclear units were generating approximately 50 percent of Sweden's electricity (Table 18), complementing 50 percent from hydropower. (See Report 196 of December 1984 for an article on Sweden's nuclear power program.)

Table 18

COMMERCIAL NUCLEAR PLANTS IN SWEDEN

Unit	Utility	MWe	Type	COD[1]
Oskarshamn 1	OKG[2]	440	BWR	Feb 1972
Oskarshamn 2	OKG	595	BWR	Dec 1974
Oskarshamn 3	OKG	1050	BWR	Aug 1985
Barsebäck 1	Sydkraft[3]	570	BWR	Jul 1975
Barsebäck 2	Sydkraft	570	BWR	Jul 1977
Ringhals 1	SSPB[4]	750	BWR	Feb 1976
Ringhals 2	SSPB	800	PWR	May 1975
Ringhals 3	SSPB	915	PWR	Apr 1981
Ringhals 4	SSPB	915	PWR	Nov 1983
Forsmark 1	FKA[5]	900	BWR	Dec 1980
Forsmark 2	FKA	900	BWR	Jul 1981
Forsmark 3	FKA	1050	BWR	Aug 1985
Total		9,455		

[1]Actual or expected Commercial Operation Date.
[2]Sydkraft AB owns 36 percent of OKG.
[3]Sydsvenska Värmekraft AB, a subsidiary of Sydkraft AB, is the owner and operator of the Barsebäck plant.
[4]SSPB = Swedish State Power Board.
[5]FKA = Forsmarks Kraftgrupp AB. SSPB owns 54.5 percent of FKA and is the operator and fuel purchaser for the plant.

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CLAB is located at Simpevarp on Sweden's east coast adjacent to the Oskarshamn power station (Figure 7). It is owned by the Swedish waste-management company SKB (Svensk [illegible]konsult AB) and operated by OKG AB, the owner of the Oskarshamn station. Asea Atom designed CLAB (Figure 8) and built it over a period of five years. The facility currently is equipped to store 3,000 MTU, and it could be expanded to hold 9,000 MTU if needed, the equivalent of the spent fuel from all 12 of Sweden's units over 30 years of operation. The actual storage section of the facility is a rock cavern located 30 meters below sea level and is approximately 120 meters long, 21 meters wide and 27 meters high. An elevator transports spent fuel from the receiving plant to the cavern, where assemblies are stored in pools of water. In addition, construction work continued during 1985 on SFR, Sweden's repository for low-level and intermediate-level radioactive waste, located under the sea floor adjacent to the Forsmark power station north of Stockholm. SFR is scheduled for commercial operation in 1988.

Sweden's operating success with nuclear power and its decisive action to close the fuel cycle have effectively countered much of the public opposition to nuclear energy. That opposition was pointedly expressed in a 1980 public referendum that called for the eventual phase-out of nuclear power. In 1981 the Swedish government set 2010 as the year by which all nuclear units would be decommissioned in accordance with the referendum. The phase-out presents a number of difficult economic problems, and

Figure 7

OSKARSHAMN NUCLEAR POWER PLANT

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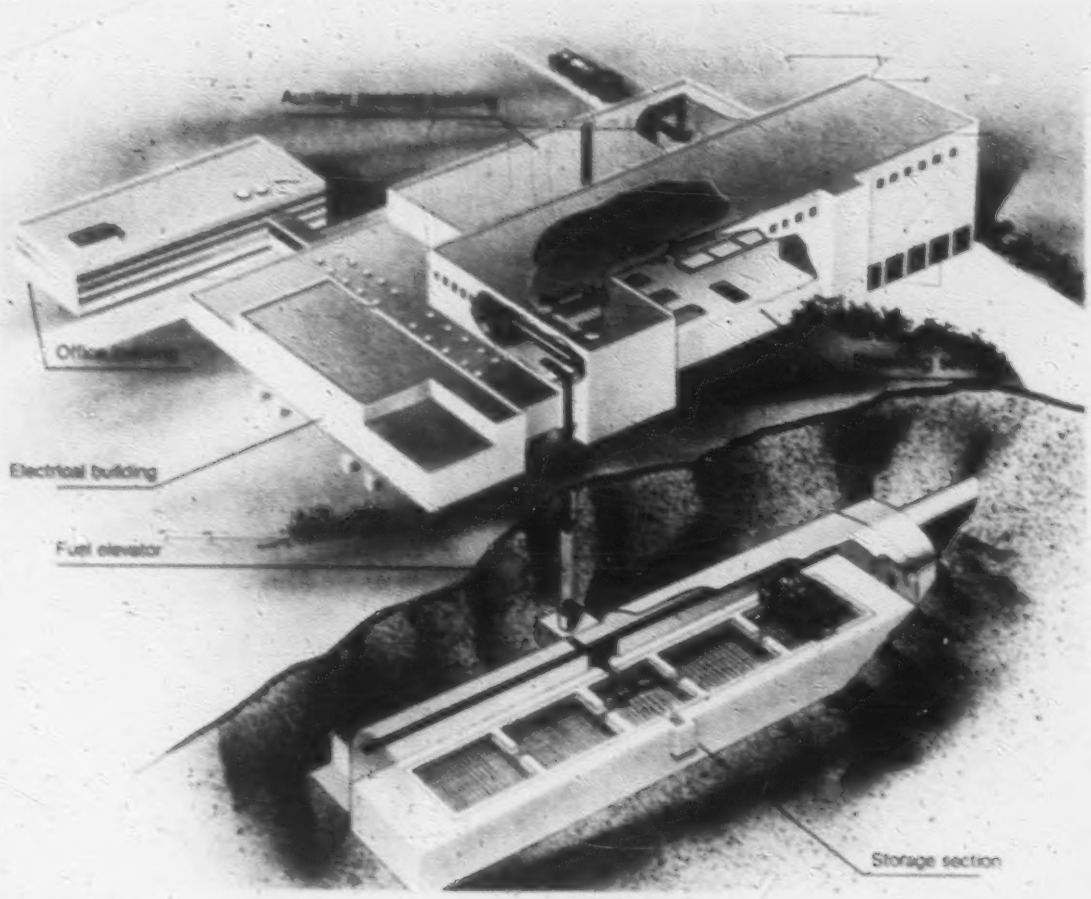
recent opinion polls in Sweden widely reflect the sentiment that either a future government or a future referendum will reverse it.

At the end of 1985 the Swedish State Power Board (SSPB), operator of the four-unit Ringhals station and the three-unit Forsmark station, was close to agreement with Saskatchewan Mining and Development Corporation (SMDC) and Western Mining Corporation of Australia (WMC) for long-term U_3O_8 deliveries beginning around 1990. Western Mining and British Petroleum Australia (BP) are co-owners of the Olympic Dam (Roxby Downs) copper-uranium-gold project in South Australia, currently undergoing development. While no long-term Swedish uranium contracts were reported in 1985, the utilities made some spot purchases. Both SSPB and OKG have signed enrichment contracts with European suppliers in recent years, while Sydkraft, owner of the Barseback station, conferred two requirements contracts to DOE's Utility Services contract in 1984. Barseback Unit 1 was shut down for refuelling in August 1985 after having operated for 371 consecutive days, a European BWR record.

Figure 8

CUTAWAY VIEW OF CLAB FACILITY



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SWITZERLAND

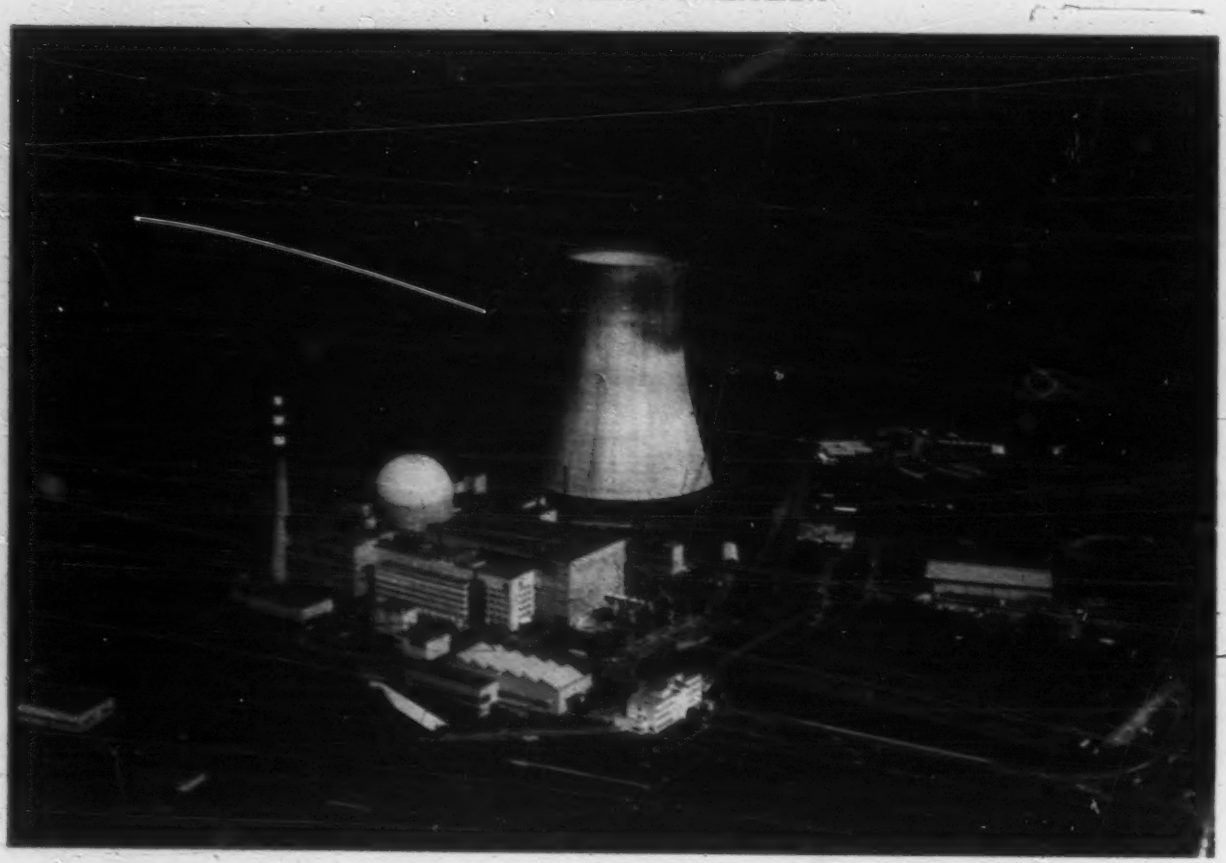
Switzerland's five nuclear power units produced approximately 40 percent of the country's domestic electricity in 1985; most of the balance came from hydroelectric stations. The share of nuclear generation increased substantially over previous years due to the operation of Kernkraftwerk Leibstadt, the 940-MWe BWR that began commercial service at the end of 1984 (Figure 9). Leibstadt was shut down for seven weeks in the summer for replacement of tubing in the condensers, but otherwise operated near full rated capacity all year. Early in 1986, the unit's rating was increased to 1,000 MWe due to excellent operation. Table 19 lists the Swiss nuclear power units.

Following the failure in September 1984 of a public referendum opposing nuclear energy, the Swiss federal parliament in March 1985 approved the need for construction of one new nuclear unit. Since the early 1970s Swiss utilities have planned to build two additional units, Kaiseraugst and Graben. Kaiseraugst was planned before Graben, so it is the unit now undergoing licensing and engineering work following the favorable federal decision. The consortium owning the project includes ten Swiss utilities and engineering groups, Electricite de France, and RWE and Badenwerk of Germany. The plant site is located along the Rhine River on the German border approximately 14 kilometers from Basel, Switzerland's second largest city. Local opposition to the construction of Kaiseraugst is overwhelming in the Basel region; technically, however, the opposition is limited by the fact that the plant site is actually located in the neighboring canton of Aargau, which favors its construction.

During 1985, representatives of the Swiss and Australian governments completed the negotiation of a bilateral uranium

Figure 9

LEIBSTADT NUCLEAR POWER PLANT



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trade agreement, signed in Bern in January 1986. Some Swiss utilities have avoided uranium of North American origin in recent years because of negative experiences with the US and Canadian governments; in that context the pact with Australia increases the number of non-North American uranium sources available to those utilities. Switzerland is not a member of the European Economic Community, and so is not subject to the bilateral agreements between Euratom and non-member countries. Three of the four operating nuclear utilities in Switzerland terminated their enrichment contracts with the US DOE and signed long-term contracts with European enrichers. The most recent such action occurred in the second half of 1985 when NOK (Nordostschweizerische Kraftwerk AG) signed its second contract with Urenco. BKW (Bernische Kraftwerk AG) is the only utility firmly committed to US supplies; it signed a Utility Services contract, and during 1985 accepted DOE's incentive pricing offer.

Table 19

NUCLEAR POWER UNITS IN SWITZERLAND

Unit	Utility	MWe	Type	COD[1]
Operating				
Beznau 1	NOK[2]	350	PWR	Dec 1969
Beznau 2	NOK	350	PWR	Mar 1972
Muehleberg	BKW[3]	320	BWR	Oct 1972
Goesgen	KKG[4]	920	PWR	Nov 1979
Leibstadt	KKL[5]	925	BWR	Dec 1984
Planned				
Kaiseraugst	KWK[6]	925	BWR	indefinite
Graben	KWG[7]	1140	BWR	indefinite

[1]Actual or expected Commercial Operation Date.
[2]NOK = Nordostschweizerische Kraftwerk AG.
[3]BKW = Bernische Kraftwerk AG.
[4]KKG = Kernkraftwerk Goesgen Daeniken AG.
[5]KKL = Kernkraftwerk Leibstadt AG.
[6]KWK = Kernkraftwerk Kaiseraugst AG.
[7]KWG = Kernkraftwerk Graben AG.

UNITED KINGDOM

The UK moved closer to the completion of its Advanced Gas-cooled Reactor (AGR) program in 1985. Heysham Unit A2 and Hartlepool Unit A2 both entered commercial service in the first half of the year, and Dungeness Unit B2 began commercial operation in January 1986, increasing total installed nuclear generating capacity in the UK to 11,748-MWe (Table 20). All three of the new units are owned by CEGB (Central Electricity Generating Board), the state utility in England and Wales. Only four AGRs are still under construction, two at Heysham and two at Torness Point in Scotland, and all are scheduled for service by the end of 1988. Thereafter CEGB plans to construct a series of PWRs on the model of recent Westinghouse plants in the USA.

Sizewell Unit B1, the subject of a two-year public inquiry that finally ended in February 1985, will be CEGB's first PWR. The conclusions of the Sizewell inspector still have not been issued and are not expected until mid-1986. Once issued, the inspector's report will be studied by the government and probably debated in parliament, so it is unlikely that any formal decision on Sizewell can be given before the end of 1986. To date CEGB has invested close to US$300 million equivalent in the project, and is in advanced stages of design work on most parts of the plant. The construction delay actually has helped CEGB's financial situation during the past two years by saving money needed to import fuel oil during the 1984-85 coal miners' strike, and by deferring dollar payments on Sizewell contracts while the pound gains against the dollar. CEGB reported a loss of 1.01 billion pounds in the financial year 1984-85 because of the miners' strike. If approval for Sizewell is granted on a reasonable schedule, CEGB plans to apply for permission to install its second PWR at Hinkley Point.

Installation of the first 1,000-MWe link of a planned 2,000-MWe grid exchange between CEGB and France's EDF was nearly completed during 1985. The link was originally designed to help optimize capacity use in the two countries through power exchanges at different hours of the day. However, it is more likely to become a vehicle for French power exports to the UK from EDF's Gravelines and Paluel nuclear stations on the English Channel. The leaders of France and the UK signed a cooperation agreement in January 1986 to build an undersea train tunnel connecting the two countries, a project that will demand a measure of future power sharing and increase the UK's economic integration with the continent. Both CEGB and the UK Atomic Energy Authority are active participants in various European nuclear energy research projects, notably involving Fast Breeder Reactors.

The British Civil Uranium Procurement Organization (BCUPO), responsible for the procurement of all of the UK's natural uranium needs, reached long-term agreement with two US uranium producers during 1985 and appeared close to agreement with an Australian producer at the end of the year. The two US producers were Energy Fuels and Everest Minerals. BCUPO has begun to diversify away from its traditional uranium suppliers in Southern Africa and Canada. BNFL, the UK's state fuel cycle company, converted approximately 7,500 MTU as UF_6 during the year at its plant in Springfield, a level close to the

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Table 20

COMMERCIAL NUCLEAR UNITS IN THE UNITED KINGDOM

Station/Unit	MWe net per Reactor	Type	Operating Entity	COD	Percent Complete
Calder Hall 1, 2, 3, 4	50	GCR	BNFL[1]	1956	100
Chapel Cross 1, 2, 3, 4	50	GCR	BNFL	1958	100
Berkeley 1, 2	138	GCR	CEGB[2]	1962	100
Bradwell 1, 2	150	GCR	CEGB	1962	100
Hunterston A1, 2	160	GCR	SSEB[3]	1964	100
Trawsfynydd 1, 2	250	GCR	CEGB	1965	100
Hinkley Point 1, 2	250	GCR	CEGB	1965	100
Dungeness A1, 2	275	GCR	CEGB	1965	100
Sizewell A1, 2	290	GCR	CEGB	1966	100
Oldbury 1, 2	300	GCR	CEGB	1968	100
Winfrith	92	HWLWR	UKAEA[4]	1968	100
Wylfa 1, 2	590	GCR	CEGB	1971	100
Dounreay	250	LMFBR	UKAEA	1976	100
Hinkley Point B1	625	AGR	CEGB	1976	100
Hinkley Point B2	625	AGR	CEGB	1977	100
Hunterston B1	625	AGR	SSEB	1976	100
Hunterston B2	625	AGR	SSEB	1977	100
Dungeness B1	625	AGR	CEGB	1984	100
Heysham A1	625	AGR	CEGB	1984	100
Heysham A2	625	AGR	CEGB	1985	100
Hartlepool A1	625	AGR	CEGB	1984	100
Hartlepool A2	625	AGR	CEGB	1985	100
Dungeness B2	625	AGR	CEGB	1986	100
Total MWe in Operation	11,748				
Heysham B1*	660	AGR	CEGB	1987	85
Heysham B2*	660	AGR	CEGB	1988	75
Torness Point 1*	660	AGR	SSEB	1987	95
Torness Point 2*	660	AGR	SSEB	1988	80
Sizewell B1**	1100	PWR	CEGB	1994	0
TOTAL MWe	15,498				

*Unit under construction.
**Unit on order and undergoing licensing.
[1]BNFL = British Nuclear Fuels Ltd.
[2]CEGB = Central Electricity Generating Board.
[3]SSEB = South of Scotland Electricity Board.
[4]UKAEA = United Kingdom Atomic Energy Authority.

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NUEXCO

EUROPE

previous year's figure. The state nuclear fuel company also announced throughput of some 1,200 MTU at the Windscale reprocessing plant in Cumbria. Windscale is adjacent to BNFL's Calder Hall Magnox station, the first commercial nuclear power station in Britain. BNFL is also a one-third owner of Urenco; expansion of Urenco's Capenhurst plant continued during 1985, while much of its SWU production supplied the UK's AGRs (see photo below).

YUGOSLAVIA

Yugoslavia's Krsko nuclear unit, a 615-MWe Westinghouse PWR owned by the Slovenian utility Savske Elektrane (50 percent) and the Croatian utility Elektroprivreda (50 percent), has been operating since December 1981. A consortium of Yugoslav utilities based in Zagreb issued an invitation for bids in October 1985 to build four additional units, and most of the international vendors are evaluating the bid documents. A request for countertrade in Yugloslav goods reportedly is a prominent characteristic of the bid package.

Domestic uranium production from Yugoslavia's Zirovski mine and mill near Ljubljana amounted to approximately 100,000 pounds U_3O_8 in 1985. The Zirovski operation started up in 1984; production is expected to double in 1986, and will be used to supply Krsko. Natural uranium requirements for the unit have been purchased on the spot market for the past few years, and enrichment is supplied by DOE.

The top of a centrifuge cascade in the Urenco centrifuge enrichment plant at BNFL, Capenhurst, England.

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JAPAN

Introduction

The progress made by Japan's commercial nuclear power program in 1985 can be summarized as follows:

1. The private utilities brought into commercial operation five nuclear units with 4,830 MWe generating capacity. As of the end of 1985, 32 nuclear units were operating with a total capacity of 24,521 MWe, approximately 14 percent of the utilities' total generating capacity.
2. For the fourth year in a row, both the average availability and capacity factors of operating plants exceeded 70 percent. The average availability factor was 75.6 percent and the average capacity factor was 74.2 percent, both of which are new annual records. Nuclear plants generated 24 percent of the total commercial electricity generation in 1985.
3. Having solved siting problems in 1984, preparations were begun to build Japan's first commercial scale enrichment, reprocessing, and low-level waste storage facilities at a single location in the northern part of Japan's main island of Honshu. The facilities will be operational in the 1990s and will allow Japan greater self-sufficiency in those services.

Nuclear Plant Status

Figure 10 shows the location of Japan's commercial nuclear plants. Table 21 summarizes the status of the 32 operating units and 16 additional units either under construction or undergoing licensing procedures. Eventual operation for the units in the licensing stage is considered certain, as site selection and preliminary designs have already been approved. Commercial operation dates might be subject to nominal adjustment in order to meet each utility's total generation plans.

The addition of 4,830 MWe to total generating capacity in 1985 established a record annual addition in the 20-year history of Japan's commercial nuclear program. Table 22 lists the annual increase in nuclear generation capacity from 1966 to 1985. Several other records were established in 1985. Tokyo Electric Power Co. (TEPCO) completed Fukushima II Unit 3 in 55 months from start of construction, a domestic record for a 1,100-MWe plant. Also, with the addition of Kashiwazaki Unit 1, TEPCO increased its total nuclear capacity to 9,096 MWe, making it the largest private nuclear utility in the world. Concurrently, Kyushu Electric Power Co. established a Japanese performance record for consecutive days of operation by operating Ikata Unit 2 for 416 days until a scheduled shutdown took place.

The record annual capacity addition in 1985 will probably not be eclipsed within the next decade. Table 21 lists an additional 16 units, with a total capacity of 16,173 MWe, currently under construction or licensing; expected dates of operation extend through 1995. Although three units will approach completion in 1986, they are not expected to reach commercial operation until 1987. Several units not listed in Table 21 are still in the planning stage, and it is doubtful that they will enter commercial operation before 1995.

Table 22

JAPANESE UTILITIES' ANNUAL ADDITION OF NUCLEAR GENERATING CAPACITY
(Gross Megawatts, 1966-1985)

Year	Annual Addition (MWe)	Total MWe at Year-end
1966-75	—	5,278
1976	2,150	7,428
1977	566	7,994
1978	3,508	11,502
1979	3,450	14,952
1980	0	14,952
1981	559	15,511
1982	1,666	17,177
1983	0	17,177
1984	2,514	19,691
1985	4,830	24,521

Installed Capacity Forecasts

The Japanese government, via the Ministry of International Trade and Industry (MITI) and in consultation with the private sector, regularly establishes planning objectives for future electrical generating capacity. In 1985, MITI maintained the following forecast of installed nuclear capacity, first established in 1984:

FY 1990 — 34,000 MWe;
FY 1995 — 48,000 MWe;
FY 2000 — 62,000 MWe.

Nuexco expects that the seven units having commercial operation dates through 1990, totaling 6,959 MWe, will be completed on schedule. This results in a total operating capacity of approximately 31,500 MWe by 1990, slightly below the MITI forecast. The remaining nine units scheduled for operation from 1991 through 1995 (totaling 9,214 MWe), when added to the total expected in 1990, would result in approximately 41,000 MWe capacity by 1995. That is likely to be the maximum because of the constraints on site availability and licensing procedures.

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FAR EAST

Figure 10

NUCLEAR POWER PLANTS IN JAPAN

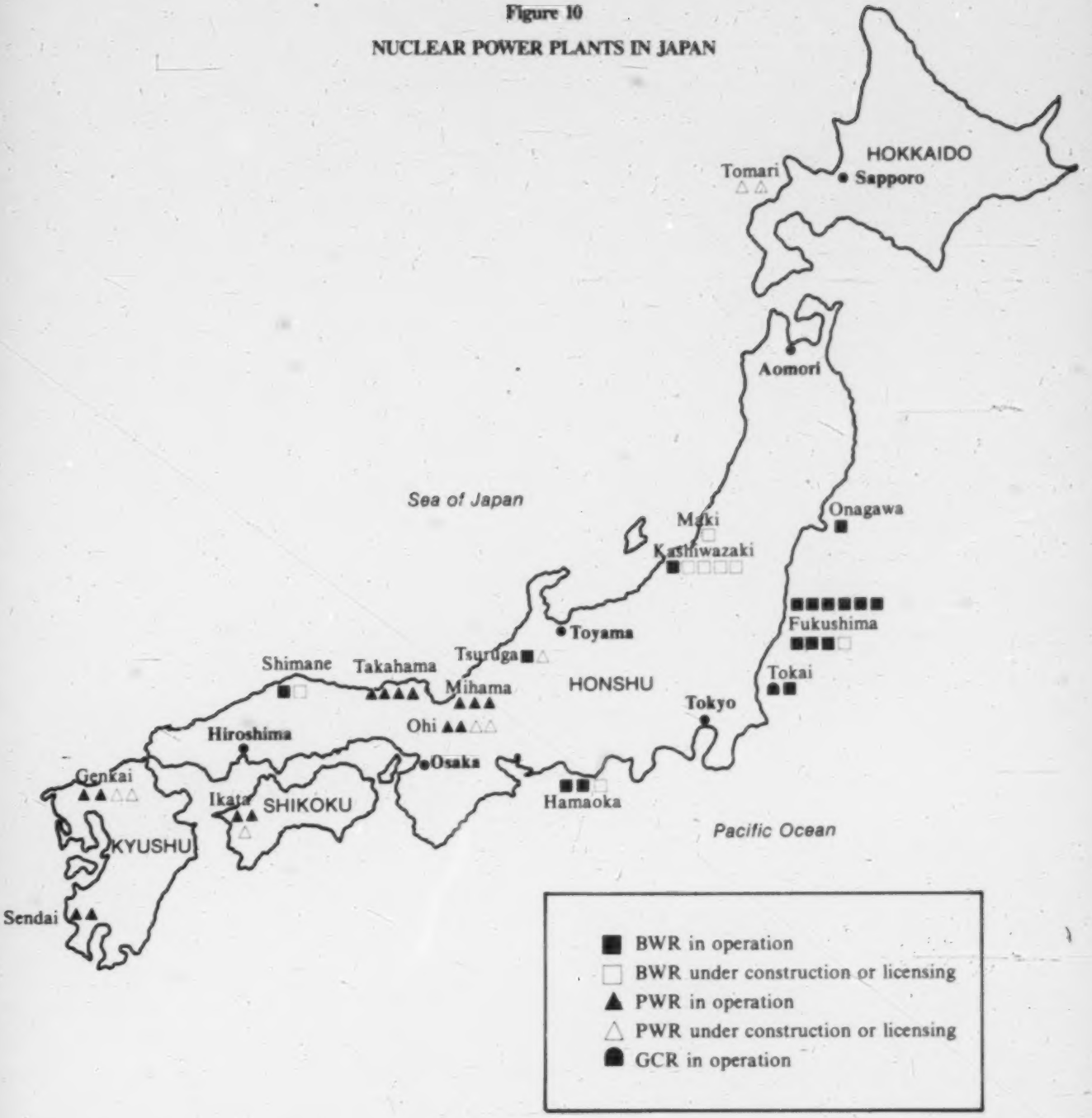

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Table 21

NUCLEAR POWER PLANTS IN JAPAN

Utility	Unit	Capacity (MWe Gross)	Type	COD[1]
Chubu EPC[2]	Hamaoka 1	540	BWR	Mar 1976
	Hamaoka 2	840	BWR	Nov 1978
	Hamaoka 3*	1100	BWR	Sep 1987
Chugoku EPC	Shimane 1	460	BWR	Mar 1974
	Shimane 2*	820	BWR	Feb 1989
Hokkaido EPC	Tomari 1*	579	PWR	Jun 1989
	Tomari 2*	579	PWR	Jun 1991
Japan Atomic Power Company	Tokai 1	166	GCR	Jul 1966
	Tokai 2	1100	BWR	Nov 1978
	Tsuruga 1	357	BWR	Mar 1970
	Tsuruga 2*	1160	PWR	Jun 1987
Kansai EPC	Mihama 1	340	PWR	Nov 1970
	Mihama 2	500	PWR	Jul 1972
	Mihama 3	826	PWR	Dec 1976
	Takahama 1	826	PWR	Nov 1974
	Takahama 2	826	PWR	Nov 1975
	Takahama 3	870	PWR	Jan 1985
	Takahama 4	870	PWR	Jun 1985
	Ohi 1	1175	PWR	Mar 1979
	Ohi 2	1175	PWR	Dec 1979
	Ohi 3**	1180	PWR	Jul 1991
	Ohi 4**	1180	PWR	May 1992
Kyushu EPC	Genkai 1	559	PWR	Oct 1975
	Genkai 2	559	PWR	Mar 1981
	Genkai 3*	1180	PWR	Mar 1993
	Genkai 4*	1180	PWR	Mar 1994
	Sendai 1	890	PWR	Jul 1984
	Sendai 2	890	PWR	Nov 1985
Shikoku EPC	Ikata 1	566	PWR	Sep 1977
	Ikata 2	566	PWR	Mar 1982
	Ikata 3**	890	PWR	Mar 1992
Tohoku EPC	Onagawa 1	524	BWR	Jun 1984
	Maki 1**	825	BWR	1995
Tokyo EPC	Fukushima I-1	460	BWR	Mar 1971
	Fukushima I-2	784	BWR	Jul 1974
	Fukushima I-3	784	BWR	Mar 1976
	Fukushima I-4	784	BWR	Oct 1978
	Fukushima I-5	784	BWR	Apr 1978
	Fukushima I-6	1100	BWR	Oct 1979
	Fukushima II-1	1100	BWR	Apr 1982
	Fukushima II-2	1100	BWR	Feb 1984
	Fukushima II-3	1100	BWR	Jun 1985
	Fukushima II-4*	1100	BWR	Sep 1987
	Kashiwazaki 1	1100	BWR	Sep 1985
	Kashiwazaki 2*	1100	BWR	Oct 1990
	Kashiwazaki 3**	1100	BWR	Jul 1993
	Kashiwazaki 4**	1100	BWR	Jul 1994
	Kashiwazaki 5*	1100	BWR	Apr 1990
Total In Operation		24,521		
Total Under Construction or Licensing		16,173		
TOTAL		40,694		

* Unit under construction.

** Unit undergoing licensing procedures.

[1] Actual or expected Commercial Operation Date.

[2] EPC = Electric Power Company.

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MITI is currently reviewing previous forecasts, and some downward adjustments might be announced in the spring of 1986, in particular for 1995 and beyond. While there is some possibility that several units now in the planning stage could become active projects and begin operation by 1995, most of those units are the first units at new sites, and generally are subject to longer licensing and construction schedules. To date, Japanese utilities have effectively implemented multiple-unit sites, shortening the schedules of the later units.

In the fall of 1985, the Agency of Natural Resources and Energy (a government agency affiliated with MITI), in its annual review of electrical generation costs, determined nuclear generation to be competitive with coal and hydroelectric facilities over the life of the plant (Report 207). Furthermore, it determined that nuclear-generated power has a definite advantage over oil and Liquid Natural Gas (LNG). Subsequently, a significant decline in oil prices combined with a much stronger yen compared to the US dollar has lowered the Japanese utility price for oil under various dollar-based supply contracts. Utility management's perception of the duration of this condition could affect the percentage of power generated by nuclear units, plant construction, and operation schedules for several years.

Uranium Inventories

In the 1970s, the Japanese utilities assured long-term deliveries for an estimated 80 percent of their future uranium needs by contracting with diversified overseas suppliers. Most of these contracts extend through the 1990s. Annual delivery quantities were based on overly optimistic generating capacity forecasts prevalent at the time. The generating capacity at the end of 1985 was only 60 to 70 percent of that forecast five years earlier, at a time when most uranium supply contracts had already started to deliver. Although it is reasonable to assume some adjustments to annual delivery quantities under contract terms, Nuexco estimates that the Japanese utilities took delivery of some 18 to 20 million pounds U_3O_8 during 1985. That total exceeds 1985 estimated requirements by approximately seven million pounds. Moreover, Nuexco estimates that the Japanese utilities collectively hold more than 60 million pounds U_3O_8 in various forms of inventory. This estimate is based on the cumulative total by which deliveries have exceeded actual needs for initial core and reload fuel requirements to date. Most contracts call for annual price renegotiation for the subsequent year's deliveries. Over the next decade, Japanese utilities will continue to receive an average of at least 15 million pounds U_3O_8 per year. That amount exceeds even the annual uranium requirements of the 41,000-MWe program forecast by Nuexco for 1995. Utility uranium inventories will continue to grow until then. 1985 deliveries were based on the negotiated price of $33 to $34 per pound U_3O_8, with some additional small reductions in place for 1986.

Nuexco estimates that as a group, the Japanese utilities are adequately supplied with uranium beyond 1995, based on current inventories and additional future deliveries. Most utilities hold inventories equivalent to 5 to 10 years' forward requirements. As of early 1985, 4 few utilities were thought to have nominal unfilled requirements in the late 1980s. One then signed a long-term contract with Canadian suppliers. Except for the possibility of external events disturbing planned deliveries, the Japanese utilities are not likely to be active in the uranium market for several years.

Enrichment

The major activity concerning enrichment services focused on the implementation of a plan for a domestic enrichment facility. The plan, conceived in 1984, calls for the construction of a 1.5 million SWU per year facility in the northern part of Honshu. Designated as Rokkasho-Mura, the plant site would also contain a reprocessing plant and a central facility for low-level waste storage, to be owned and operated by the utilities.

In March 1985, the utilities, as the major shareholders, organized Japan Nuclear Fuel Industries (JNFI) to own and operate the enrichment facility. Site environmental surveys and preliminary license preparations were initiated. The facility's technology will be based on centrifuge technology developed by the Power Reactor and Nuclear Fuel Development Corporation (PNC). PNC is a quasi-government agency which developed the technology as a national project, primarily with government funding. Arrangements were completed to transfer the centrifuge technology from PNC to JNFI, but commercial terms have not yet been negotiated.

JNFI plans a progressive expansion of the enrichment facility. An initial capacity of 150,000 SWU per year is planned for 1991, followed by an expansion to 1.5 million SWU per year by 1997. Plant hardware will be supplied by Japan's three major nuclear manufacturers; Toshiba, Hitachi, and Mitsubishi Heavy Industries (MHI). These three companies participated as main subcontractors in PNC's previous enrichment development program. In 1985 their joint-venture manufacturing company, Uranium Enrichment Manufacturing Co. (UEM), began construction of a new facility to produce centrifuge machines. Production will start late in 1986.

JNFI's initial plans called for a capacity of 3 million SWU per year at Rokkasho-Mura by the year 2000. That capacity would supply approximately one-third of utilities' estimated annual needs at that time. However, in mid-1985 the USDOE, which will continue to be a major enrichment supplier to Japanese utilities even after completion of the new Japanese facility, announced the cancellation of its Gas Centrifuge Enrichment

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Process (GCEP) program in favor of laser technology. Consequently, the Japanese utilities reevaluated their domestic program based on future technology and related economics. By the end of 1985, the utilities had decided to limit Rokkasho-Mura capacity to 1.5 million SWU per year, and tentatively decided to build another facility, with equal capacity based on laser technology, at a different location. The laser technology is to be developed using a combination of government and private sector funding. Concurrently, DOE officials approached the Japanese utilities for financial support (a reported 2 billion dollars) for the DOE laser development program. In return for financial support, the Japanese utilities would obtain some price concession on future enrichment services from DOE, depending on the interest on funds provided. Negotiations on the matter were continuing as of the end of 1985.

In November 1985, PNC began construction of a 200,000 SWU per year demonstration centrifuge enrichment facility on the western side of Honshu. The plant will act as a technology bridge between the PNC pilot plant (which confirmed PNC's centrifuge technology) and the JNFI commercial-scale plant. Equipment installation at PNC's new plant will commence in late 1986. Annual production of [illegible] SWU is scheduled for 1987 with full capacity could be reached by 1988. UEM will supply the centrifuges. The plant output will serve the utilities' commercial power plants and is estimated to provide enrichment for two reloads annually.

Reprocessing

In 1985, the Japan utilities, via Japan Nuclear Fuel Services (JNFS), continued with plans to build an 800 ton per year reprocessing plant at Rokkasho-Mura. JNFS is proceeding with environmental survey and licensing activities. It will introduce reprocessing technology which is based on technology developed by the French company Fragema. JNFS also concluded basic negotiations whereby MHI, with support from other nuclear manufacturers, would serve as the prime contractor for the new facilities. Prior to this plant's scheduled operation in 1995, JNFS plans to complete by 1991 a storage facility capable of storing 3,000 tons of spent fuel.

PNC will also have an advisory role in the reprocessing facility, having built and operated the 210 ton per year Tokai-Mura demonstration reprocessing plant as part of a national development program. In April 1985, PNC restarted the Tokai-Mura demonstration plant, which has encountered numerous hardware problems since its start-up in 1977. Dissolver corrosion had caused the plant to be shut down since late 1983. PNC reprocessed in excess of 70 tons of spent fuel from the Japanese utilities in 1985. Plans for 1986 include the reprocessing of 140 tons of spent fuel. Technology is similar to that used by JNFS in its commercial plant.

Other Reactors

In October 1985, PNC began construction of its often-delayed 280-MWe Monju Fast Breeder Reactor (FBR). The plant, originally scheduled for operation in 1985, is now scheduled for criticality in October 1992. Present construction cost is estimated to be the equivalent of US$3 billion, a 58 percent increase over the last project estimate in 1979. In November 1985, the nine private utilities announced they would delegate to the Japan Atomic Power Company (JAPC) the development activity for the design of a demonstration FBR to follow the Monju plant. JAPC, owned primarily by the utilities, acts as a vehicle to introduce new commercial reactor concepts. In the past, JAPC built Japan's first gas-cooled reactor as well as the first generation of LWR plants. The electricity produced by those units is sold wholesale to JAPC's owners.

Since 1979 PNC has successfully operated a 165-MWe advanced thermal reactor (ATR), a [illegible] light-water cooled reactor fueled with slightly enriched uranium. The ATR is viewed as a bridge between the present commercial LWRs and future FBRs. In 1985 the Electric Power Development Corporation (EPDC) proceeded with plans to build a 600-MWe demonstration ATR, based on PNC's technology, in northern Honshu. EPDC is a quasi-government wholesale utility which to date has undertaken a large portion of Japan's hydroelectric development projects. EPDC completed preliminary negotiations with local governments and hopes to apply for plant licenses for the ATR in 1986. Construction is tentatively scheduled for April 1989, and the plant could be in operation by 1995. EPDC expects the total cost will exceed the equivalent of US$2 billion.

Both the FBR and ATR are part of a national program established in the late 1960s to reduce natural uranium needs, due to Japan's total reliance on overseas supply of uranium. Initial plans called for the recycling of plutonium and depleted uranium for those reactors by the 1990s. However, the current status of the programs indicate these objectives will not materialize until well into the next century. Japan's commercial LWRs, using enriched uranium, will continue to be the primary basis of nuclear generation for the next several decades.

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FAR EAST

PEOPLE'S REPUBLIC OF CHINA (PRC)

Nuclear Power

The People's Republic of China continued to pursue plans for an ambitious nuclear program. The outline of the program includes the development of nuclear power in eastern and southern provinces with projected generating capacities of 2,000 MWe in 1990 and 10,000 MWe in 2000. Figure 11 shows the location of the 26 provinces in China. Based on the history of development of nuclear power programs in other countries, such a plan involving the operation of 10 to 12 pressurized water reactors (PWRs) by 2000 is quite optimistic.

Chinese experience in nuclear power has been rather limited. In addition to a series of plutonium-generating reactors used for military purposes, the Chinese have operated two small research reactors in Beijing: a 3.5-MWe swimming-pool type unit and a 7-MWe heavy-water reactor later uprated to a greater output. The Atomic Energy Research Institute in Shanghai has conducted research on reactor design, developing prototype reactors for electricity and industrial steam generators. In 1984, a 27-MWe PWR became operational. The next steps in China's nuclear program are likely to be among the following:

1. Officials hope to complete the Qinshan plant, a Chinese-designed 300-MWe PWR near Shanghai. The project will require a number of imported components, including a pressure vessel from Mitsubishi Heavy Industries. The scheduled operation date is 1989.

2. The construction of two PWRs in the Guangdong province, known as the Daya Bay project, is scheduled to begin. The reactor probably will be a Framatome design, and turbines may be supplied by the UK's General Electric Company.

3. Two units are planned for East China, probably near Shanghai. The current plan called for a two-unit station, consisting of 1,000-MWe PWRs. Negotiations were underway with German and Brazilian firms. On March 2, 1986, however, Chinese officials informed the West German reactor supplier Kraftwerk Union (KWU) that negotiations for the purchase of the two units were indefinitely postponed for organizational and financial reasons. Other planned projects include at least three additional stations, each having twin 900-MWe units, located in three different provinces.

It remains to be seen whether the Chinese will be able to commit the huge investment required to complete these projects. A recent report issued by the World Bank concluded that nuclear power in China must compete with low-cost coal and other demands on the nation's financial resources. Thus, for these and other reasons, the successful implementation of all of the planned projects within their projected schedules is not likely to occur.

Uranium Resources

According to official statements, China has enough uranium resources to operate at least 15 reactors for thirty years. With the strong potential for new discoveries in the southeast, China is now considered to be a country with significant uranium resources on an international scale. Total reserves of over 800,000 tons of uranium are possible, and uranium occurrences have been reported in the Xinjiang, Qinghai, Inner Mongolia, Liaoning, Gansu and Guangdong Provinces.

In particular, the Yunnan-Guangxi Plateau is an important area of uranium mineralization in which several large discoveries have been made. In December 1979, officials announced that they had discovered sufficient reserves to support 30 large mines. The deposits are thought to be located near Quantou in southern Guangxi, near the border with the Guangdong Province. In February 1982, the discovery of a series of high-grade deposits in early Tertiary rocks of the Yunnan/Fenghuang area of the Yunnan Province was announced. Uranium deposits in sedimentary rocks also occur in southeast China, in such deposits as Chenhsien in the Hunan Province, and Chaozhping and Taoling in the Guangxi Province.

In the northeast, two significant discoveries have been announced. One of these is a large deposit in the Sanma alkaline massif. The second discovery was made in 1978 at Liaoshangnan, in the Liaoning Province near the Korean border. It is a small deposit, but is of some geological significance in that it bears a similarity to localized deposits in northern Australia.

The Chinese consider these natural uranium resources to be very important in their effort to solicit foreign participation and financial assistance in upcoming industrial expansion. China has been offering uranium for sale on the international market, chiefly to generate opportunities for countertrade. In some cases, nuclear cooperation between China and other nations involves the trading of Chinese uranium.

Nuclear Cooperation Agreements

For the aforementioned reasons, and in an effort toward greater involvement in the world market, China signed several technical and commercial agreements with various countries in 1985.

1. President Reagan signed the USA-China nuclear cooperation pact on December 16, 1985. The joint resolution, passed by both bodies of Congress, requires a presidential certification of China's compliance with non-proliferation policies.

2. In early December, France and China signed an agreement in principle concerning the cost of the two-unit Daya Bay nuclear station in the Guangdong Province, 50 miles northeast of Hong

Figure II
CHINA'S PROVINCES

Kong. The project is a joint venture between the Guangdong Electric Authority and the China Power and Light utility. Under the agreement, Framatome will supply two 900-MWe PWRs and Electricite de France will conduct overall project management.

3. Following the Franco-Chinese agreement, the UK's General Electric Company signed a similar agreement for conventional equipment and turbogenerators at the plant.

4. The West German utility Gemeinshaftskernkraftwerk Neckar GmbH (GKN), was reported to be in negotiations with China for the procurement of natural uranium. The negotiations include such issues as spent fuel and technology countertrade. Reports indicate that uranium prices in the negotiations are competitive with current market prices for uranium contracts. In China's marketing efforts in Germany and Switzerland, Kraftwerk Union has provided assistance, and is trying to establish countertrade opportunities in support of the possible sale of KWU reactors to the Chinese.

5. The Uranium Resources Development Committee (URDC) of Japan indicated it will initiate a joint feasibility study with China for the mining of uranium reserves at Qinglong. Chinese agencies have supplied URDC with preliminary geological data for evaluation. If the study proceeds, a detailed site evaluation will be made over a two-year period to confirm reserves and to plan its development. No information regarding the size or nature of the deposit was released, although the possibility of starting to mine as soon as 1991 was mentioned. To minimize initial investment, labor intensive production methods may be utilized instead of a highly mechanized operation, and current production costs may be less than US$20 per pound U3O8.

THE PHILIPPINES

The only nuclear power plant in the Philippines, Bagac/San Juan Unit 1 (also known as Philippines National Power Plant 1, PNPP-1), had been officially scheduled to begin commercial operation in the first quarter of 1985. However, the issuance of an operating license is still pending. The National Power Corporation (NPC) has filed suit in Manila against Westinghouse over contractual payments resulting from the delay in the issuance of the operating license. In spite of lower oil prices, the delay puts a serious financial burden on the utility, which had anticipated the startup of the 620-MWe, two-loop PWR in 1985.

In recent years, considerable public opposition surrounded the plant's operation, intensifying in the last months of the Marcos regime. Licensing hearings in June 1985 drew large crowds, followed by the sabotage of 13 transmission towers connecting the plant to the capital city of Manila. Immediately prior to her election, President Corazon Aquino stated that the plant, which she considered unsafe, would be scrapped if she was elected. In the first month of her rule, however, no further announcements have been made regarding the future of the plant. The Philippine Supreme Court recently blocked licensing of the plant, ordering that a hearing on safety and other issues be reopened.

Anticipating the eventual commercial operation of PNPP-1, the Philippines National Power Corporation remains in the market for the purchase of uranium. However, the financing terms required by the utility and the perceived risks have not been attractive to potential sellers. NPC on at least two occasions has failed to conclude uranium supply contracts because of financing difficulties.

SOUTH KOREA

In September 1982, the Korea Electric Power Corporation (KEPCO) began commercial operation of its fourth nuclear plant, Ko-Ri Unit 5, located on the southwest coast of Korea (Figure 12). The 895-MWe PWR was supplied by Westinghouse, the turbine-generator by General Electric Co. of Britain, and Bechtel Power Corporation performed the architect-engineering. KEPCO currently operates two PWRs, Ko-Ri Units 1 and 2, and one Candu unit, Wolsung. Five PWRs, three Westinghouse and two Framatome units, are under construction (Table 23).

Later in 1985, following some delays, Korean officials invited nuclear plant vendors, turbine-generator manufacturers, and architect-engineers to bid on Korea Nuclear Units 11 and 12. According to the official plan, the addition of these two units by 1996 will enable Korea's nuclear energy to provide over 43 percent of its total electric power demand. In the bid invitation, Korea will favor competitive bids with an emphasis on technology transfer in order to strengthen its self-reliance in nuclear energy.

Table 23

NUCLEAR POWER UNITS IN SOUTH KOREA

Unit	Plant	MWe	Type	COD[1]	Percent Complete
KNU 1	(Ko-Ri)	556	PWR	1978	100
KNU 2	(Ko-Ri)	605	PWR	1983	100
KNU 3	(Wolsung)	629	Candu	1983	100
KNU 5	(Ko-Ri)	895	PWR	1985	100
KNU 6	(Ko-Ri)	895	PWR	1986	100
KNU 7	(Yeonggwang)	900	PWR	1986	98
KNU 8	(Yeonggwang)	900	PWR	1987	90
KNU 9	(Ul-Jin)	895	PWR	1988	64
KNU 10	(Ul-Jin)	895	PWR	1989	50

[1]Actual or expected Commercial Operation Date

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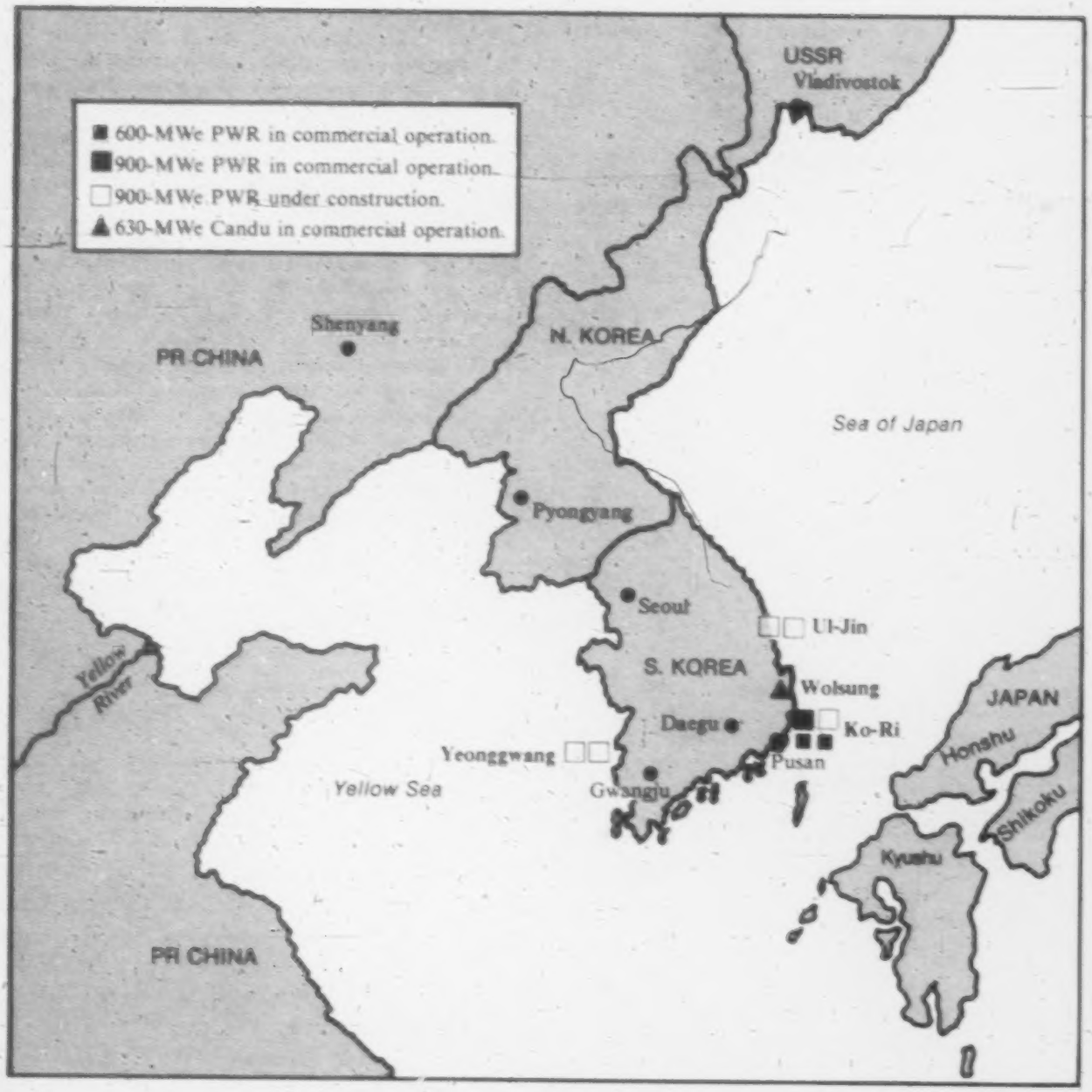
Figure 12

NUCLEAR POWER UNITS IN SOUTH KOREA



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FAR EAST

In general, Korea seeks to increase the degree of autonomy and self-sufficiency in its nuclear program. The Korea Power Engineering Corporation (KOPEC), an engineering subsidiary of KEPCO, is promoting the development of local architect-engineering capability through joint ventures and agreements with overseas companies. KEPCO also manages and partially owns Korea Heavy Industries and Construction (KHIC), and is helping KHIC to localize the construction of all major hardware components by the end of the 1980s. KHIC, as the sole designated Korean manufacturer, is the umbrella licensee to the main supplier companies abroad. KHIC hopes to award subcontracts in the future to smaller Korean companies.

Korea also announced its intent to build its own fuel fabrication plant, which is scheduled to begin commercial production in the 1990s. Kraftwerk Union was recently selected to build the plant at the Daeduk complex near Taejon, south of Seoul. The plant, which officials believe could be completed by 1989, will have a nominal annual production capacity of 200 MTU, and will supply enough fuel for the eight Korean PWRs scheduled to be in operation at that time. Eventually, the plant will be controlled by KEPCO and the Korea Advanced Energy Research Institute (KAERI). Initially KEPCO considered participation by some foreign interests, but the plan was later rejected.

In 1985, KEPCO signed a ten-year enrichment contract with Cogema for thirty percent of the enrichment needs of eight light water reactors in the 1990s. The contract covers three Westinghouse units in operation, three Westinghouse units under construction, and Units 11 and 12, which have not yet been ordered. The contract will supplement an existing contract between KEPCO and Cogema for the enrichment requirements of the Framatome units under construction at Ul-Jin. The balance of enrichment requirements will be provided by the US DOE. KEPCO also signed a uranium contract with Energy Resources of Australia (ERA), under which deliveries are reported to begin in 1991. This contract will supplement an existing arrangement with ERA for uranium supply, and some of the delivery years in the two contracts will overlap.

The future of the Korean nuclear program and the pace of new nuclear plant orders essentially will depend on the growth in electricity demand in Korea. A decision on Units 13 and 14 may be made in 1987. In general, government policy has been based on the desire to achieve a balance between coal and nuclear power for electricity generation, with nuclear power continuing largely as baseload generation.

TAIWAN

When Maanshan Unit 2 began commercial operation on May 18, 1985, Taiwan Power Company (Taipower) had increased the number of operating nuclear plants in Taiwan to six, and had concluded its current nuclear power plant construction program (Table 24). Maanshan Units 1 and 2 are 890-MWe Westinghouse PWRs, located at the southern tip of Taiwan.

At present, there are no plans for additional units in Taiwan. In 1983, Taipower had received bids from General Electric, Westinghouse, Combustion Engineering, Framatome and Kraftwerk Union for the Yenliao project, to be located east of Taipei on the northern coast. The two units would have been 900-MWe reactors scheduled for commercial operation in 1993 and 1994. However, subsequent economic developments, chiefly a lower rate of economic growth, failed to produce the projected electricity demand, so the government did not grant approvals for the project. There had been indications in 1984 that Taipower would revive plans to build the additional units, but some public opposition to the construction and repeated concerns over economic matters delayed a commitment. Again, the program could not gain government approval. Nevertheless, Taipower still plans to install enough nuclear units to account for more than 40 percent of total electricity generation by year 2001.

Similarly, other Taipower projects have experienced some delays. In particular, negotiations for a joint venture agreement between Taipower and Rocky Mountain Energy for an exploration program in the USA were announced in 1984. However, the required government approvals for such an agreement had not yet been released. Taipower is not likely to consider participation in other ventures until a decision is reached regarding additional nuclear units.

Table 24

NUCLEAR POWER UNITS IN TAIWAN

Unit	MWe	Type	COD
Chinshan 1	604	BWR	Dec 1978
Chinsan 2	604	BWR	Jul 1979
Kuosheng 1	948	BWR	Dec 1981
Kuosheng 2	948	BWR	Mar 1983
Maanshan 1	890	PWR	Jul 1984
Maanshan 2	890	PWR	May 1985

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REPUBLIC OF SOUTH AFRICA

Overview

Despite wide-ranging economic and social troubles in South Africa in 1985, the nation's gold and uranium operations experienced another profitable year. In fact, as the South African economy began to lose the confidence and support of the international banking community, the plummeting rand caused prices under contracts denominated in US dollars to soar in rand terms, thereby generating record revenues for gold producers. Once again, record gold prices in rand terms assured a successful year for the uranium industry, since most of the uranium mined in South Africa is extracted as by-product or co-product of gold operations.

Economic Developments

In early 1985, the economy seemed to be emerging from three years of deep recession. But just as interest rates were dropping and economic activity was increasing, the escalation of racial violence caused foreign investors to become anxious about the security of South African investments. The imposition of emergency financial controls and the withdrawal of credit by international banks in mid-1985 brought further pressure on an economy beset by the effects of external political sanctions, whether symbolic, as in the case of President Reagan's Executive Order and the European Community's sanctions, or real, such as divestment (see Report 205 [September 1985] for an analysis of these and other issues). As of the end of the year, South African officials were attempting to reach a settlement regarding the nation's foreign debt crisis. It has been reported that sweeping political reforms are necessary before South Africa's creditors will agree to reschedule some $14 billion of short-term debt.

The reintroduction of the two-tiered exchange rate in September 1985 resulted in the establishment of the financial rand, currently traded at a discount of approximately 25-percent from the commercial rand. The financial rand is chiefly used for foreign trading in South African securities listed on the Johannesburg Stock Exchange. Implemented to stimulate foreign investment, the financial rand was first instituted in the early 1960s, and was abolished in 1983 when the economy was particularly strong. After initially trading at a discount of about 10 percent against the commercial rand, the discount widened to over thirty percent in November and continued to fluctuate. In general, the size of the discount varies inversely according to the degree of foreign confidence in the South African economy.

A short-lived strike in September by members of the National Union of Mineworkers, the country's largest and most powerful black trade union, failed to have a significant impact on uranium production. Only two uranium operations were affected, and the mass firing of striking workers by Gold Fields of South Africa Ltd. broke the strike and discouraged the union, which was short on resources to sustain its members, after three days. The processing of stockpiled ore allowed for the continuance of full output.

Regardless of the problems encountered in 1985, the large stockpiles held by producers will continue to keep uranium supply channels open for the foreseeable future. Moreover, the importance of gold revenues to the South African economy dictates that gold, and therefore uranium, production will certainly continue.

Uranium Production

Total production of 12.2 million pounds U_3O_8 in 1985 represented a 15-percent decline from the 1984 level. The chief reason for this drop was the cessation of mining operations at Beisa and Blyvooruitzicht at the end of 1984. Beisa, which had consistently produced about one million pounds annually, was shut down because of sharply increasing losses. Being a primary uranium producer with gold as a by-product, the mine was unable to rely on gold operations to remain profitable. Blyvooruitzicht, a relatively high-cost producer, ceased uranium production in November 1984. In all, eight producers experienced declines in production totaling about 2.8 million pounds, two-thirds of which was attributed to Beisa, Blyvooruitzicht, and Chemwes. The only significant increase occurred at Buffelsfontein, which produced about 220,000 pounds more than in 1984. Table 25 shows a breakdown of uranium production among the thirteen Chamber of Mines operations in 1985. In general, the South African uranium industry has now shut down its unprofitable plants and has curtailed production so that it matches current contract commitments.

Palabora Mining Company Ltd., which is not a member of the Chamber of Mines, produced 478,000 pounds U_3O_8 in 1985, an increase of approximately 25 percent from the 1984 level. In its latest report to shareholders, however, the company announced that there had been no sales of uranium concentrates in 1985, reportedly because of greatly increased revenues from copper sales.

Specific Comments on Production Operations

Beisa (St. Helena) and **Blyvooruitzicht.** Because of unprofitable operations, the Beisa mine was closed and allowed to flood at the end of 1984. The project had been unprofitable since production began in 1982. The owners have sold 14.5 million rand worth of the project's assets thus far. At Blyvooruitzicht, sales from the stockpile continued during 1985,

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but production ceased in November 1984. Ore stockpiles are sufficient to supply the remaining commitments, which expire in 1987.

Buffelsfontein. Production increased 16 percent at this high-grade mine. In general, the grades have stabilized over the past year, although tonnage has fallen.

Chemwes (Stilfontein). Production fell by almost fifty percent in 1985. This mine's gold resources are running out, but its uranium production continues from the treatment of surface slimes. Chemwes reduced throughput to 60 percent of capacity in 1985 due to reduced current demand, and probably will not increase its uranium production significantly in 1986.

Driefontein Consolidated. Production fell 45 percent, mostly due to decreased throughput and yield. Although grade has declined steadily, this mine is one of the lowest-cost producers in the industry.

East Rand Gold and Uranium Co. Ltd. (ERGO) (Figure 13). This company retreats old slimes (tailings) dams in the East Rand. Production fell more than 50 percent because of decreased throughput, chiefly due to maintenance and repairs to the mill. This was completed in late 1985, and the mill is now operating at full capacity.

Harmony. This mine recorded a small decline in production in 1985, mainly due to the 1984 closure of the Merriespruit plant, one of three plants that Harmony Gold Mining Co. Ltd. operates. No other cutbacks have been announced, however, and uranium revenue improved during 1985.

Hartebeestfontein. Production remained constant in 1985 for this rich mine. Better grades and higher tonnage increased working profits.

Free State Joint Metallurgical Scheme (JMS). Production remained virtually constant in 1985.

Randfontein. Production increased slightly in 1985, as the company is engaged in expansion through the development of the Doornkop gold mine. Although the latest ore reserves show a decline in tonnage and grade, the increased use of efficient mechanized mining should increase output.

Vaal Reefs (Figure 14). The Vaal Reefs/Southvaal complex continued to be the largest producer in South Africa. Despite a 15-percent tonnage increase at the Southvaal area, uranium

Table 25

**REPUBLIC OF SOUTH AFRICA:
1985 URANIUM PRODUCTION[1]
(Thousands of Pounds U_3O_8)**

Operation	First Quarter 1985	Second Quarter 1985	Third Quarter 1985	Fourth Quarter 1985	Total 1985
Beisa (St. Helena)	0	0	0	0	0
Blyvooruitzicht	0	0	0	0	0
Buffelsfontein	401	378	366	428	1,573
Chemwes (Stilfontein)	148	148	160	139	595
Driefontein Consolidated	45	47	51	48	191
ERGO[2]	83	76	92	95	346
Harmony	256	225	225	234	940
Hartebeestfontein	239	222	243	240	944
JMS[3]	314	356	348	310	1,328
Randfontein	291	319	363	371	1,343
Vaal Reefs	1,156	799	1,137	1,059	4,151
Western Areas	150	189	171	178	687
Western Deep Levels	62	57	0	0	119
TOTAL[4]	3,145	2,816	3,154	3,102	12,218

[1]Excludes Palabora Mining Company, which is not a member of the Chamber of Mines.
[2]ERGO = East Rand Gold and Uranium Co. Ltd.
[3]JMS = Free State Joint Metallurgical Scheme.
[4]Columns may not add due to rounding.

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production declined approximately five percent in 1985. Future production could depend on output from the No. 10 shaft in the South lease area.

Western Areas. Production rose slightly at this relatively low-grade mine. The deeper, higher-grade sections of the mine cannot be fully exploited for several more years. In 1986 work will focus on the ore bodies of the Upper Elsburg series, and by the end of 1986 about 20 percent of the ore will be obtained from mechanical mining techniques.

Western Deep Levels. Traditionally a small uranium producer, the company ceased uranium production in the second quarter of 1985. The uranium plant has been converted into a gold treatment plant, commissioned in August at a cost of 35 million rand. The closure will reduce South Africa's annual output by about 400,000 pounds U_3O_8.

Nuclear Power

The Electricity Supply Commission of South Africa's (Escom) Koeberg Unit 2 reached criticality in July, and entered commercial operation in November 1985. Koeberg Unit 1, which had entered commercial service for a short time in 1984 before being shutdown for cooling pipe inspections in January 1985, reentered operation in June 1985. Both of the units are 920-MWe PWRs, supplied by the French companies Framatome, Alsthom-Atlantique and Framateg. The Koeberg station is likely to be the only commercial nuclear-generating power facility in South Africa, as declining growth rates for electricity demand and low coal costs have postponed the need for more nuclear units.

Figure 13. Aerial view of ERGO's uranium production plant in the East Rand.

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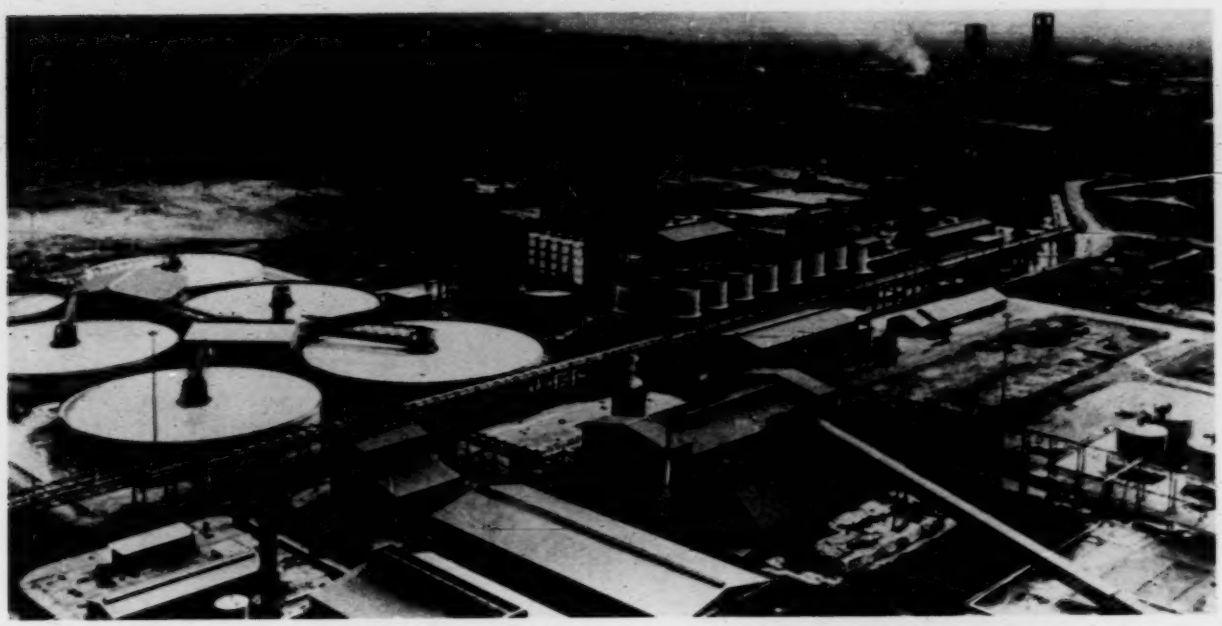
SOUTHERN AFRICA

Figure 14. Aerial view of the Vaal Reefs South uranium production facility.



NAMIBIA

Rossing, the world's largest open-pit uranium mine, is the sole source of uranium production in Namibia. Exact production figures have not been released, but Nuexco estimates that 1985 production totaled approximately nine million pounds U_3O_8, a slight drop from the 1984 level. Nuexco expects production to remain at that level for the immediate future.

The Republic of South Africa, which has retained control over Namibia despite a 1967 United Nations General Assembly mandate establishing the United Nations Council for Namibia as the *de jure* governmental authority, installed what it termed a transitional government in Namibia in June 1985. Shortly thereafter, the Industrial Development Corporation of South Africa (IDC) transferred part of its 13.5-percent ownership interest in Rossing Uranium Limited to the new government. Although the shares total only 3.5 percent of the equity, the shares reportedly account for a majority of the voting rights in Rossing by virtue of their being weighted more heavily than others. The transfer also gave the new government the right to nominate one of the nineteen members of the Rossing board, for the first time giving a Namibian government full access to information on the mine's operations.

Rio Tinto Zinc Corporation retained its controlling ownership interest in the Rossing project and continued as the project's operator, so the ownership transfer caused no operational changes (Table 26). Moreover, the new Namibian government's ties to South Africa signalled a continuation of established policy. The transfer probably stemmed from South Africa's desire to legitimize the new government in the international forum by giving it some economic influence over one of the country's important resources.

Table 26

REVISED OWNERSHIP OF ROSSING URANIUM LTD.

Company	Country	Percent Share
Rio Tinto Zinc Corp.[1]	UK	41.35
Industrial Development Corp.	South Africa	10.0
Total Compagnie Miniere	France	10.0
Rio Algom Ltd.[1]	Canada	10.0
Urangesellschaft mbH	FRG	5.0
General Mining Corp.	South Africa	6.5
Windhoek government	Namibia	3.5
Undisclosed		13.65

[1] RTZ owns 51.3 percent of Rio Algom, so RTZ's net beneficial interest in Rossing is 46.5 percent.

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UNITED STATES

Nuclear Power

Compared to the past several years, conditions in the US nuclear industry improved considerably in 1985. An indication that 1985 could be termed a transition year for nuclear power in the USA was the fact that no nuclear plants were canceled, an event that last occurred in 1973. In 1984 alone, eight units were canceled. Instead, a total of eight plants began commercial service in 1985, increasing total installed generating capacity to approximately 85,000 megawatts. Nine units received full-power licenses, and four of those attained commercial status (Figure 15). The total number of licensed reactors reached 99, including units having low-power licenses. Table 27 summarizes the licensing progress of US nuclear plants during 1985.

Table 28 lists those units scheduled *by their operating utilities* to attain commercial operation status in 1986, including two units which have already begun commercial service this year. According to the schedules, 18 reactors are expected to enter service in 1986, representing about 18,000 megawatts of installed capacity. Nuexco expects seven of these units will actually achieve that status. Table 29 lists US plant construction progress in descending order of completion percentage as of December 31, 1985. In addition, Nuexco expects that Three Mile Island Unit 1 will reenter the ratebase this year. The unit has been shut down since the 1979 accident at Unit 2.

Although overall spot market purchasing continued at approximately the same level as in 1984, US utility uranium procurement strategies in 1985 placed increased emphasis on long-term contracts. The perception that market prices had reached a low point, combined with the fact that many supply agreements made in the late 1970s had begun to expire, contributed to the increased long-term procurement by US utilities. Most of the US utility contracts concluded or in negotiation during 1985 involved US or Canadian producers. Several utilities reportedly signed contracts with Energy Resources of Australia (ERA) for long-term supply despite the existence of the Australian government floor price, currently about US$30 per pound U_3O_8. Because it is unlikely that US utilities would agree to terms that could require them to buy large amounts of uranium at prices substantially higher than market prices, it is probable that the contracts are in effect call options that allow considerable delivery flexibility. For example, the contracts might stipulate that the utilities may call on ERA for deliveries if and when the spot market price exceeds the Australian floor price.

Political Developments

Two issues dominated the uranium industry in the USA during 1985. The ongoing lawsuit between three US uranium producers and DOE reached a crucial point in September, when a District Court judge ruled in favor of the producers on one count of the lawsuit. Concurrently, US Secretary of Energy John Herrington

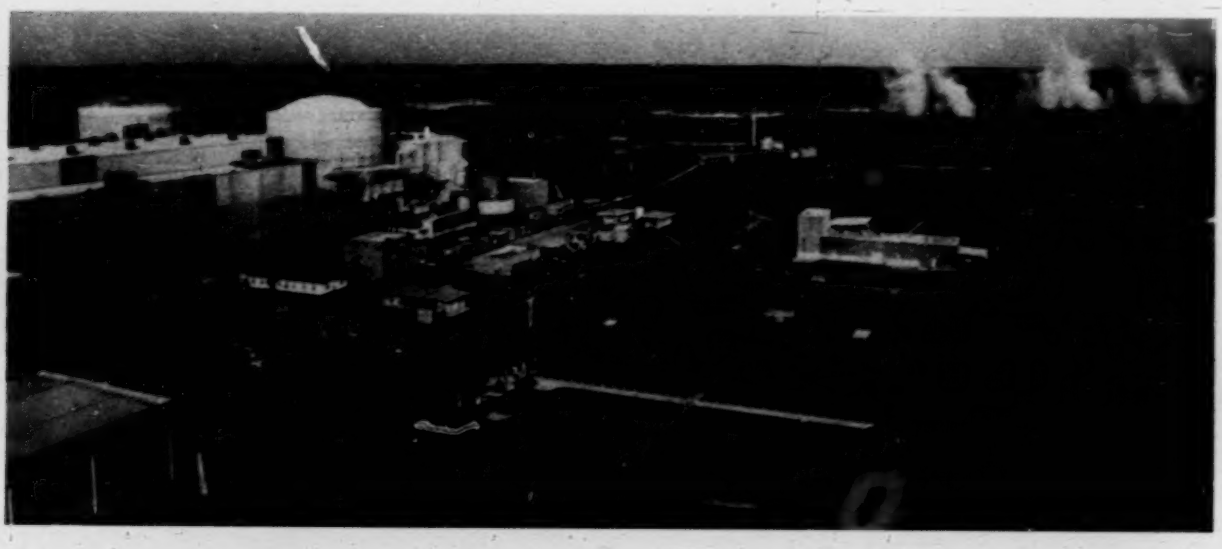

Figure 15. Duke Power Company's Catawba plant, located near Clover, South Carolina. Unit 1, center left, began commercial operation in June 1985. Unit 2, far left, is scheduled for commercial service in 1987, but could enter operation in late 1986.

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UNITED STATES

declared the US mining and milling industry non-viable, prompting wide-ranging questions regarding the impact of such a declaration.

The invalidation of the USEC, also covered in Report 206 and the *Enrichment* section of this Review, stemmed from Judge Carrigan's ruling on Count II of the five-count civil suit. That Count specifically addressed the validity of the USEC. Other counts in the suit, however, were still under Judge Carrigan's consideration as of early 1986. Several made specific references to uranium supplies.

Count I requested a reimposition of the US embargo on foreign uranium, asserting that DOE is obligated to limit the enrichment of foreign-origin uranium for domestic end-use so as to "assure the maintenance of a viable domestic industry." Although observers anticipated that Herrington's declaration of the non-viability of the industry would expedite a decision on this count, no ruling has been made.

Count V sought judicial validation and enforcement of the principle that the US industry shall be maintained in a condition such that it shall be capable of supplying 100 percent of US requirements at any time, and under any hypothetical scenario for supply disruption.

With the words "I have taken steps to help the miners and millers in this important industry that is currently under a great deal of strain," Energy Secretary Herrington authorized three steps designed to relieve the domestic uranium industry:

1. The US Trade Representative was asked to examine the facts and implications of uranium imports and corresponding foreign trade and policy issues, and will recommend appropriate courses of action.

2. The variable tails assay option (VTAO) will be offered free of charge to utilities committed 100 percent to the USEC over a rolling five-year period. This item was sought under the still-pending Count III of the producers' suit against DOE.

Table 27

US NUCLEAR UNITS' LICENSING PROGRESS DURING 1985

Unit	Utility	MWe Net	Type	COD
Entered Commercial Operation				
Susquehanna 2	Pennsylvania Power & Light	1050	BWR	Feb 1985
Callaway 1	Union Electric	1150	PWR	Apr 1985
Diablo Canyon 1	Pacific Gas & Electric	1084	PWR	May 1985
Catawba 1	Duke Power Company	1145	PWR	Jun 1985
Grand Gulf 1	Mississippi Power & Light	1250	BWR	Jul 1985
Waterford 3	Louisiana Power & Light	1104	PWR	Sep 1985
Wolf Creek	Kansas Gas & Electric	1150	PWR	Sep 1985
Byron 1	Commonwealth Edison	1120	PWR	Sep 1985
TOTAL		9,053		
Received Full-Power License				
Limerick 1	Philadelphia Electric	1055	BWR	Feb 1986
Palo Verde 1	Arizona Public Service	1270	PWR	Feb 1986
River Bend 1	Gulf States Utilities	940	BWR	Mar 1986
Fermi 2	Detroit Edison	1100	BWR	Mar 1986
Diablo Canyon 2	Pacific Gas & Electric	1106	PWR	Apr 1986
TOTAL		5,471		
Received Fuel-Loading, Low-Power Testing License				
Millstone 3	Northeast Utilities	1150	PWR	May 1986
Palo Verde 2	Arizona Public Service	1270	PWR	mid-1986
Shoreham	Long Island Lighting	809	BWR	indefinite
TOTAL		3,229		

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3. DOE's plans to utilize its stockpile as enrichment feed will be postponed for one year. This item was also sought in the producers' suit (Count IV).

One of the reasons given for Herrington's declaration of non-viability was the US mining industry's reported loss of more than $200,000,000 for 1984. That amount was a decline of $240,000,000 from 1983, when the industry reported a net profit and then-Energy Secretary Hodel declared the industry viable. To date, the declaration of non-viability has had no direct effect. The US Trade Representative's subsequent report did not support any corrective action under existing law which would allow for long-term relief. At present, the possibility of a limitation or embargo of non-US-origin uranium seems unlikely in view of the Reagan Administration's anti-protectionist stance. Workers in larger industries such as steel and automobile manufacturing have been denied similar relief. Moreover, most US utilities oppose any type of embargo.

Closely tied to these issues is the problem of mill tailings cleanup legislation, which will continue to be the subject of deliberations in 1986. While US producers still active in the uranium production business are probably most concerned with the prospect of an embargo on the importation of non-US uranium, many producers that were forced to shut down their operations are primarily interested in the outcome of mills tailing legislation.

Table 28

US NUCLEAR UNITS NEARING COMPLETION IN 1986

Unit	Utility	Net MWe	Type	COD
In Commercial Operation				
Limerick 1	Philadelphia Electric	1055	BWR	Feb 1986
Palo Verde 1	Arizona Public Service	1270	PWR	Feb 1986
Scheduled for Commercial Operation				
River Bend 1**	Gulf States Utilities	940	BWR	Mar 1986
Fermi 2**	Detroit Edison	1100	BWR	Mar 1986
Diablo Canyon 2**	Pacific Gas & Electric	1106	PWR	Apr 1986
Millstone 3*	Northeast Utilities	1150	PWR	May 1986
Shoreham*	Long Island Lighting	820	BWR	1986
Palo Verde 2*	Arizona Public Service	1270	PWR	mid-1986
Perry 1	Cleveland Electric	1205	BWR	Jun 1986
Clinton 1	Illinois Power	933	BWR	Jul 1986
Hope Creek 1	Public Service E & G	1070	BWR	Sep 1986
Byron 2	Commonwealth Edison	1120	PWR	Oct 1986
Braidwood 1	Commonwealth Edison	1120	PWR	Oct 1986
Seabrook 1	New Hampshire Yankee	1150	PWR	Oct 1986
Nine Mile Pt 2	Niagara Mohawk	1085	BWR	Oct 1986
Shearon Harris	Carolina Power & Light	900	PWR	late 1986
Watts Bar 1	Tennessee Valley Authority	1177	PWR	1986
Three Mile Island 1[2]	General Public Utilities	819	PWR	1986
TOTAL		16,965		

*Indicates the unit had a low-power license as of the end of 1985.
**Indicates the unit had a full-power license as of the end of 1985.
[1]Data from published sources.
[2]Three Mile Island Unit 1 is scheduled to reenter the ratebase in 1986.

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Table 29

US NUCLEAR UNITS UNDER CONSTRUCTION AND ON ORDER

Unit	Utility	Net MWe	Type	Percent Complete	COD
Fermi 2	Detroit Edison	1100	BWR	100	Mar 1986
Shoreham	Long Island Lighting	809	BWR	100	indefinite
Diablo Canyon 2	Pacific Gas & Electric	1106	PWR	100	Apr 1986
River Bend 1	Gulf States Utilities	940	BWR	100	Mar 1986
Palo Verde 2	Arizona Public Service	1270	PWR	100	mid-1986
Perry 1	Cleveland Electric	1205	BWR	100	Jun 1986
Hope Creek 1	Public Service E & G	1070	BWR	100	Sep 1986
Catawba 2	Duke Power Company	1145	PWR	100	Jun 1986
Millstone 3	Northeast Utilities	1150	PWR	99	May 1986
Commanche Peak 1	Texas Utilities	1150	PWR	99	Jul 1987
Watts Bar 1	Tennessee Valley Authority	1177	PWR	99	1986
Palo Verde 3	Arizona Public Service	1270	PWR	99	mid-1987
Clinton 1	Illinois Power	933	BWR	98	Jul 1986
Nine Mile Point 2	Niagara Mohawk	1085	BWR	95	Oct 1986
Seabrook 1	Yankee (New Hampshire)	1150	PWR	95	Oct 1986
Shearon Harris	Carolina Power & Light	900	PWR	94	late 1986
Beaver Valley 2	Duquesne Light Company	833	PWR	90	Aug 1987
Braidwood 1	Commonwealth Edison	1120	PWR	90	Oct 1986
Vogtle 1	Georgia Power Company	1100	PWR	89	Jun 1987
Watts Bar 2	Tennessee Valley Authority	1177	PWR	85	Apr 1988
South Texas 1	Houston Lighting and Power	1250	PWR	83	Dec 1987
Bellefonte 1	Tennessee Valley Authority	1213	PWR	83	1995
Byron 2	Commonwealth Edison	1120	PWR	82	Oct 1986
Comanche Peak 2	Texas Utilities	1150	PWR	78	Dec 1987
WPN 3	Washington PPSS	1240	PWR	75	indefinite
South Texas 2	Houston Lighting and Power	1250	PWR	65	Jun 1989
WPN 1	Washington PPSS	1250	PWR	63	indefinite
Braidwood 2	Commonwealth Edison	1120	PWR	59	Dec 1987
Perry 2	Cleveland Electric	1205	BWR	57	indefinite
Bellefonte 2	Tennessee Valley Authority	1213	PWR	54	1996
Vogtle 2	Georgia Power	1100	PWR	53	Sep 1988
Grand Gulf 2	Mississippi Power & Light	1250	BWR	33	indefinite
Limerick 2	Philadelphia Electric	1055	BWR	31	Oct 1990
Seabrook 2	Yankee (New Hampshire)	1150	PWR	23	indefinite
Carroll County 1*	Commonwealth Edison	1120	PWR	0	2001
Carroll County 2*	Commonwealth Edison	1120	PWR	0	2002

*Indicates unit is on order

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Production, Exploration and Development

The decline of activity in all phases of the uranium production industry continued through its fifth consecutive year. Active and potential producers are still waiting for higher market prices and industry stability. Nevertheless, only a rapid and sizeable market recovery will end the debate over the industry's viability. The Exchange Value low of $14.25 in April acted as a trigger for further producer recession; several companies responded almost immediately by relegating their projects to standby or shut-down status. By the end of the year, exploration and mining levels had fallen below those in 1950.

Nuexco estimates production from all sources in 1985 to be approximately 11.1 million pounds U_3O_8, down from 14.9 million pounds in 1984. Nine conventional mills were in production during January, but only three operated throughout the year; the other six mills were taken out of service before mid-year. Two mills were started-up in the fourth quarter, one of which was again placed on stand-by at the end of the year. Approximately 5.4 million pounds U_3O_8 were produced at conventional mills, about 3.3 million pounds were produced from phosphate production, and the remaining concentrates came from solution and heap-leach mining. Table 30 gives the operating status of conventional mills throughout 1985.

Project Activity

Nuexco estimates 1985 exploration and development drilling to be 1.8 to 2.0 million feet, the lowest level since 1950. The surface drilling rate has now declined for the seventh consecutive year (the all-time high was 47 million feet drilled in 1978). Exploration geologists were active primarily in northern Arizona, but also carried out some limited work in the following areas:

— Live Oak, Duval and Kleberg counties of the South Texas district;
— northwestern Nebraska;
— three Tertiary basins in Wyoming; and
— southeastern Utah.

Success was primarily limited to significant high-grade mineralization discovered in breccia pipes located in northern Arizona. Discoveries in other areas were mostly confined to extensions of known deposits and projections along mineral and structural trends. These discoveries generally have a lower uranium content, but are important in sustaining industry activity in the particular area.

The past exploration successes in northern Arizona resulted from extraordinary effort on the part of active companies. At present there are at least four major mining companies, plus approximately 16 small companies and independent operators, exploring in the district. Each employs its own techniques to discover uranium associated with solution-collapse structures in Permian and Mississippian sediments. Not all of the companies have enjoyed exploration success; in fact, only Energy Fuels Nuclear, Inc. has announced recent discoveries. Pathfinder Mines Corporation and Rocky Mountain Energy Company have implemented aggressive exploration programs which may have resulted in limited success, although neither company made an announcement to that effect.

About five companies conducted new exploration projects in the South Texas district in 1985. Drilling was concentrated on targets in the Goliad Formation, where past experience indicates the greatest potential for large, high-grade deposits. In addition,

Table 30

1985 OPERATING STATUS OF CONVENTIONAL URANIUM MILLS IN THE USA
(O = Operating, S = Stand-by)

Company	Jan.	Jul.	Dec.	Location
Bear Creek Project	O	O	O	Powder River Basin, WY
Chevron Resources Co.	O	S	S	Hobson, TX
Conter Corp.	O	S	O	Canon City, CO
Homestake Mining Co.	O	S	S	Grants, NM
Pathfinder Mines*	O	S	S	Gas Hills, WY
Pathfinder Mines	O	O	O	Shirley Basin, WY
Petromerics Corp.**	O	S	S	Shirley Basin, WY
Quivira Mining Co.	O	S	S	Grants, NM
Rio Algom Corp.	O	O	O	La Sal, UT
Union Carbide & Energy Fuels	S	S	O	Blanding, UT

*Closed for expiration
**Decommissioned in 1985.

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Oxidized ores have proven conducive to solution mining techniques. Favorable oxidized mineral trends were explored in Duval, Brooks and Kleberg counties. Activity continues along the known trends in the Oakville Sandstone, primarily in Live Oak and Bee counties, but to a lesser degree. No announcements of important new discoveries were made in 1987.

Mining activity throughout the district was at its lowest level in about seven years. Chevron Minerals Corporation stopped mining the district's only conventional open pit mines and acid mill and began pit reclamation in April. Milling operations ended in June. Chevron controls additional reserves in the general vicinity of the mill site. The future status of the mill is probably dependent upon a tentative development schedule of these reserves. There are five operating solution mines in the district, down from ten in 1982:

1. Mobil Corp., mining the Holiday-O'Meara deposit near Bruni.

2. Intercontinental Energy Corp. (IEC), mining the Zamzow deposit at Three Rivers.

3. US Steel Corp., mining both the Clay West and Burro Ranch deposits near George West.

4. Chevron Minerals Corp., mining the Mt. Lucas deposit, in southern Live Oak County.

5. Chevron Resources Corp., mining the Palangana Dome in Duval County. Production potential from the five properties is about 3.8 million pounds annually, but 1987 production totaled an estimated 1.8 million pounds. US Steel remains the largest single producer in the district.

In Nebraska, exploration activity was limited to three or four companies, all active in Dawes and Box Butte counties in the northwest corner of the State. No new discoveries were announced. Therefore, the Crow Butte project, controlled by the Wyoming Fuels Co./Power Exploration Co. joint venture, remains the only uranium deposit under consideration for development within the state. A pilot plant for testing the feasibility of solution mining is under construction at Crow Butte. The 100-gallon-per-minute plant is scheduled to be operating by mid-1988. Two 5-spot well patterns are in place and ready for operation to determine favorable well pattern design and [illegible] plant leach technology. The leach test program will continue for approximately 12 months, followed by an additional four to six months testing to demonstrate formation restoration procedures. Upon completion of a successful pilot test, the joint venture will be capable of commercial production.

Exploration and development activities in Wyoming were limited to the Powder River Basin, Gas Hills and Shirley Basin. In the Powder River Basin, Uranerz Minerals Corp. continued to test portions of the Highland ore deposit for solution mining in anticipation of moving up in the near future to commercial production. The Central Electricity Generating Board (CEGB) of Great Britain purchased the Lucas/Berger property, located in the southern part of the basin, in August. The property is a potential in-situ leach (ISL) uranium [illegible] permits are already in place as a result of a successful pilot ISL program conducted in 1987.

Malapai Resources acquired the remaining 50 percent interest in the Christensen Ranch property from Western Nuclear Inc., and secured a two-year option to purchase the Irigaray property and ISL plant from Westinghouse. Preproduction [illegible] is progressing to initiate solution mining studies on both properties, possibly beginning in mid-1988. Furthermore, Malapai has tentatively scheduled commercial production from at least one of several potential ore deposits on the properties in late 1987 or early 1988. At present the only sustained production in the Powder River Basin is from two small solution mining operations by Sequoyah Fuels Corp. The recovery centers are part of the Bill Smith property, which was originally developed as an underground mine in the late 1970s.

Pathfinder Mines is the only operator in the Gas Hills and Shirley Basin regions. In March, the Gas Hills mill was closed for renovation prior to the continuation of mining at the Lucky Mc mine and any new projects that may be scheduled for future development. In December, Pathfinder also acquired a property controlled by Petrominerals, suggesting that an additional ore source will be available to sustain operations at the Shirley Basin mill.

The October 1 reopening of the Union Carbide/Energy Fuels White Mesa mill located near Blanding was the high point of activity in southeastern Utah. The mill is processing stockpiled ore from Energy Fuels' three Black Canyon mines and the Pigeon mine. Additional ore is trucked from the mines in northern Arizona to the mill, a distance of over 300 miles. The mill is scheduled to continue operation through 1988.

The Rio Algom mill in La Sal, Utah continued operation throughout the year in order to increase the ore supply. Rio Algom purchased custom ore from independent miners. The opportunity to sell ore slightly supplemented the local industry; seven mines were reopened and new project evaluation was [illegible] in some cases. Rio Algom is now scheduling operations throughout 1988.

In the same district, Minatome City satisfied annual assessment requirements by drilling exploration adits into several ore deposits to establish ore body characteristics and obtain bulk samples for metallurgical testing. The ore deposits are now ready for mining should Minatome decide to move ahead with its uranium program. The several hundred tons of ore mined were processed at the nearby Rio Algom mill.

Events that further affected the US uranium industry in 1987 are listed chronologically in Table 3.

Table 31
1985 URANIUM-RELATED ACTIVITIES IN THE USA

UNITED STATES

Month	Organization	Event or Announcement
Jan	Quivira Mining Co.	Announced full stand-by status for all mines and mill within next few months, Grants, New Mexico.
Jan	Western Nuclear, Inc.	Shutdown Ruby Lake Mine, Grants, New Mexico.
Jan	Homestake Mining Co.	Mill restart after 3-month down period, Grants, New Mexico.
Jan	Rio Algom Corp.	Shutdown Mi Vida mine, La Sal, Utah. 4Q
Feb	Chevron Resources Co.	Announced plan to re-open Mt. Taylor mine for 12-month period of engineering and economic evaluation, Grants, New Mexico.
Feb	Cotter Corp.	Mill placed on stand-by, Canon City, Colorado.
Feb	Western Nuclear, Inc.	Announced intent to sell all uranium properties.
Mar	UNC Resources Corp.	Announced intent to dispose of all uranium properties.
April	Homestake Mining Co.	Announced suspension of milling and cutback on all mine activity, Grants, New Mexico.
April	Anaconda Mining Co.	Announced plan to sell all uranium properties.
May	US Government	Legislation for a $1 billion fund to clean up active uranium tailings piles in US sent to Congress.
June	Texaco Minerals Co.	Decommissioning of Petromerics mill underway, Shirley Basin, Wyoming.
June	Rocky Mt. Energy/ Mono Power, Inc.	Announced termination of joint venture agreement for all uranium projects, including the Bear Creek project, Powder River Basin, Wyoming, effective 7-1-85.
June	Amoco Minerals Co.	To transfer all mineral projects to Cyprus Minerals Corp., 7-1-85.
June	Uranium Producers of America	Filed suit against DOE regarding uranium enrichment policies.
July	Anaconda Mining Co.	Announced intent to sell entire mining company.
Aug	State of Wyoming	Filed "friend of the court" brief before US District Court in support of UPA lawsuit regarding DOE's uranium enrichment policies.
Sep	Homestake Mining Co.	Closed mill and reduced mining to two crews and recovery from mine waters, Grants, New Mexico.
Sep	Energy Fuels Nuclear	Entered exploration joint venture with CEGB, Arizona Strip district.
Sep	State of New Mexico	State and DOE agreed on procedure for stabilizing the Phillips/UNC tailings; first such agreement ever for the industry.
Sep	US DOE	Declared US uranium industry to be nonviable.
Oct	Conoco, Inc.	Concluded ISL production and began full restoration, Trevino project, Hebbronville, Texas.
Oct	Cotter Corp.	Start-up of mill at Canon City, Colorado.
Nov	Uranium Resources, Inc.	Resubmitted mining application to the Texas Water Commission for the Kingsville Dome project, near Kingsville, Texas.
Dec	Minatome Corp.	Entered exploration joint venture with Concord Oil Corp. on property in vicinity of Palangana Dome, Duval County, Texas.
Dec	Cotter Corp.	Closed mill after 3-month run, Canon City, Colorado.
Dec	Quivira Mining Co.	Request made to Bureau of Land Management for stand-by status of Church Rock mines in final review. If granted, mines will be sealed and allowed to flood.

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